COMPARATIVE STUDY OF TOTAL LATE POSTOPERATIVE ASTIGMATISM BETWEEN PHACOEMULSIFICATION AND MANUAL SICS

A DISSERTATION SUBMITTED IN PARTIAL
FULFILLMENT OF THE
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CONTENT

PART I

Part II

Department of Ophthalmology,
Madurai medical college,
Government Rajaji Hospital,
Madurai

CERTIFICATE

This is to certify that the dissertation entitled **"COMPARATIVE STUDY OF TOTAL LATE POSTOPERATIVE ASTIGMATISM BETWEEN PHACOEMULSIFICATION AND MANUAL SICS"** submitted by **Dr. DEEPTHI .T.S.** to the Faculty of Ophthalmology, The Tamilnadu Dr. M.G.R. Medical university, Chennai in partial fulfillment of the requirement for the award of M.S. Degree in Ophthalmology is a bonafide work carried out by her during the period of August 2007 – July 2009 under my direct supervision and guidance.

Place : Madurai

Date :

Professor and Head
Driector and Professor Ophthalmology,
Madurai Medical College,
Madurai.

DECLARATION

I, DR.DEEPTHI.T.S. solemnly declare that the dissertation titled **"COMRAPATIVE STUDY OF TOTAL LATE POSTOPERATIVE ASTIGMATISM BETWEEN PHACOEMULSIFICATION AND MANUAL SICS"** has been prepared by me.

This is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment of the requirement for the award of master of ophthalmology, Branch III degree Examination to be held in March 2010.

Place : Madurai

Date :

DR.DEEPTHI.T.S.

INTRODUCTION

The use of the intraocular lens implant has been the most exciting development in ophthalmology of the last quarter century. So, during the past 2 decades the advances in cataract surgery have produced better visual outcome and induced less astigmatism.

Improvement by means of shortened healing time, a less cumbersome post-operative period, reduced chances of complication and a more predictable outcome. This demand for improvement can be satisfied by universal application of small incision surgery which allows faster and safer healing and reduced suture induced astigmatism. Two principal surgical techniques are used.

1. Phacoemulsification and posterior chamber intraocular lens implantation.
2. Manual small incision sutureless cataract surgery with posterior chamber intraocular lens implantation.

Hence, this study is an attempt of comparison of total late astigmatism between manual SICS and phacoemulsification of 100 cases at Govt. Rajaji Hospital.

HISTORICAL REVIEW

Dr. Richard Kratz was the first surgeon to move the cataract incision from the limbus to the sclera increasing the surface of the apposed wound edges. This was expected to enhance the wound healing, thereby control surgically induced astigmatism. Girard and Hioffman were the first to call posterior incision a sclera tunnel incision.

In 1989, Mc Farland introduced an incision (Two-plane incision) architecture that was self-sealing. He observed that his sclera tunnel wounds appeared to be watertight before the placement of a suture and that the horizontal suture actually caused bleeding in some cases. Tying the suture knots seemed to distort the sclera tunnel and thus cause slight leakage. He hypothesized that if the following condition were met, the wound will become self-sealing.

(1) The incision started far enough behind the surgical limbus
(2) The sclera tunnel was kept very narrow (i.e. 3mm)
(3) Vertical cuts were made in the floor of the sclera tunnel to give a spreading effect, much like an accordion

In 1983, Gerald t. Keener JR, pioneered the alternative method of mall incision cataract extraction which combined the advantages of a standard Phacomulsification with those of a conventional Extra capsular cataract extraction.

Later, Paul Ernest introduced the concept of an internal corneal lip (Three plane incision) acting as a one way valve. This corneal lip not only imparted a self sealing to this incision but also prevented the development of Hyphaema and delayed filtering blebs.

REVIEW OF LITERATURE

Astigmatism

Is the type of refractive anomaly in which no point of focus is formed owing to unequal refraction of incident light by diaptric system of eye in different meridians, but form focal lines.

Visual status in Astigmatism

In patients with low astigmatism (<1.0D) there occurs transient blurring of vision when doing precision work at a fixed distance, which is relieved by closing or rubbing the eyes. The patient makes an effort to focus one meridian clearly and the meridian nearest to emmetrope is chosen. More often the patient exhibits a preference for vertical meridian when the error is high the blurring of vision is marked. Further since a focal line is made the object of attention, the vision in an astigmatic patient in addition to being indistinct shows following peculiarities:

- Circles become elongated into ovals
- A point of light appears tailed off
- A line appears as and succession of strokes fused in to a blurred image.

The diminution in visual acuity is about equal for corresponding degree of simple hypermetropic and myopic astigmatism and is considerably less than that caused by an equal degree of myopia or absolute hypermetropia, as measured by snellens type. It is greatest when the more positive axis is vertical, intermediate when it is oblique and least when horizontal, in which case the visual loss is about ½ that caused by a spherical error of equal power.

The corrected visual acuity in the lower degree of astigmatism can usually be brought upto normal standard or above, but in higher degree this is by no means always the case, particularly if optical correction not made in early life and also if astigmatism is oblique [Bonavolenta and Simona 1960]. This deficiency is essentially perceptual and there may be a tendency for poor differentiation to be accounted in meridian of greatest astigmatism. Amblyopia exonopsia is more common in the highest degree of astigmatism and there is a tendency to develop strabismus particularly in presence of hypermetropic error.

Astigmatism and near vision

Accommodation may alter the nature of image appreciably in astigmatism by varying the position of focal lines, so that a hypermetropic focal line may be focused on retina. This is possible and usually done in hypermetropic and in mixed astigmatism when most posterior focal lines is imaged. But myopic astigmatism cannot be improved in this way except for distance greater than the far point.

Clinical symptoms

The constant effort to see clearly is a prolific cause of eye strain. This is especially evident in hypermetropia and mixed astigmatism owing to the accommodative stress undergone. Particularly so in the case of small astigmatism errors, for here the measure success which the accommodative effort achieves stimulate it to a greater endeavor. Small errors, which do not cause discomfort, may be accepted as physiological and do not require treatment. But in other cases all the symptoms of eyestrain may be present. Headache varying from mild headache to violent explosions of pain, dizziness, neurosthesia irritability, factique and a whole gamut of reflex nervous disturbance.

A characteristic attitude is occasionally seen. If the axis of cylinder is oblique, the head is frequently held to one side so as to reduce the distortion, a habit which may in children, lead to development of scoliosis and in all cases there is a tendency to half close the lids in order to make a stenopaeic slit, so that by cutting out rays of one median the object may appear more distinct.

TYPES OF ASTIGMATISM

I. Regular Astigmatism :

Astigmatism ordinarily depends upon the presence of toroidal instead of spherical curvature of the refractive surfaces of the eye, the refractive power as a whole therefore, instead of being equal in all meridians, it changes gradually from one meridian to the other by uniform increments and each meridian generally has a uniform type of curve. Such a condition is called Regular Astigmatism by Donder (1864) and is correctable by cylindrical lenses. According to Duke Elder, as a rule the major and minor meridians are at right angles.

In about 90% of cases where in vertical curvature greater than horizontal is termed direct or with the rule astigmatism in contradiction to opposite condition or Indirect or against the rule astigmatism.

Oblique astigmatism is a type of regular astigmatism where the two principal meridian are not horizontal or vertical though they are at right angles to one another.

In Bioobliqe astigmatism two principal meridian are not right angle to each other, but are crossed obliquely.

When parallel rays of light undergo refraction by an astigmatic system two focal lines are formed lying at the focal points of the meridians of greatest and least curvature. Depending upon the position occupied by the two focal lines.

Regular astigmatism may be classified thus as :

A. Simple Astigmatism:

Where in one of the focal lines falls upon the retina when the eye is at rest, the other focal line may fall infornt or behind the retina, so that while one meridian is emmetropic the other is either myopic or Hypermetropic. These are respectively designated as simple Myopic and simple Hypermetropic astigmatism.

B. Compound Astigmatism:

In this condition neither of the two focal lines lies upon the retina, but are both placed infront or behind it. The state of refraction is then entirely Hypermetropic or entirely Myopic. The former is known as Compound Hypermetropic Astigmatism and the latter is known as Compond Myopic Astigmatism.

C. Mixed Astigmatism:

Where one focal line is infront and the other behind the retina, so that the refraction is Hypermetropic in one direction and Myopic in the other.

II. Irregular Astimatism:

Irregularities in the curvature of the meridians so that to no geometrical figure is adhered to the condition is called irregular astigmatism as in cases of corneal disease or lenticular sclerosis. Such a defect can not be compensated by spectacle but can be, in so far as it is corneal, by contact lenses.

CAUSES OF ASTIGMATISM

A. CORNEAL

i. Physiological
ii. Age Related
iii. Congenital
iv. Trauma

B. LENTICULAR

i. Physiological
ii. Accommodative
iii. Congenital
iv. Traumatic

C. SURGICAL

i. Excessive cautery
ii. Location of incision
iii. Incision length
iv. Incision depth and configuration
v. Suture materials and suture pattern
vi. Diameter of sutures
vii. Number of sutures
viii. Suture tension
ix. Decay

D. RESIDUAL ASTIGMATISM

E. PSUEDOPHAKIC ASTIGMATISM

F. RETINAL ASTIGMATISM

MEASUREMENT OF CORNEAL ASTIGMATISM

Corneal astigmatism may be measured by

A. Refraction

B. Keratometry

C. Corneal Topography

The corneal astigmatism should be determined at different points in time. The same method should be used when comparing measurements.

A. REFRACTION

It determines the astigmatism of the entire eye and not only the corneal astigmatism. The refractive cylinder may be obtained objectively by retinoscopy or automated refractometer or subjectively by manifest refraction. The axis of the cylinder determined by refraction will usually be similar to that determined by keratometer, unless the astigmatism is lenticular or arises from psuedophakos, although its magnitude may vary considerably. In a patient with a high degree of hypermetropia or aphakia, the refractive cylinder may be significantly less than that measured by the keratometer. The opposite is the case with very high myopic corrections.

B. KERATOMETRY

Keratometry directly measure the radius of anterior corneal curvature over a central area approximately 3mm in diameter. Measurement of astigmatism with a keratometer eliminates the variables vertex distance, lens effectivity, patient objectivity and astigmatism induced by IOL. In addition to measuring regular astigmatism, the Keratometer can determine the presence of central irregular astigmatism by evaluating the quality of the images of the mires.

Several guidelines for determining postoperative astigmatism may be followed.

A) Use the same method when comparing measurements taken at different points in time.

B) Calculate the vector corrected astigmatism to obtain the most accurate representation of the amount of astigmatism produced or corrected by a surgical procedure.

C) Use objective rather than subjective measurements.

Since our study deals only with postoperative cases, only surgically induced astigmatism will be dealt in detail.

Pathophysiology of Astigmatism following cataract surgery:

A. WOUND RELATED

1. WOUND COMPRESSION

Produced by tight sutures – Over tightening during surgery.

Suture induced astigmatism – Postoperative tissue edema.

- Any suture pattern.

- May be associated with both non absorbable / absorbable – sutures
- Typically seen in immediate post operative period and is with the rule
- Stable until sutures are cut / bio degraded
- Reduced or eliminated by suture removal.

2. WOUND GAPE

- Typically associated with surgically induced Astigmatism
- Typically against the rule
- Usually caused by alignment – shallow suture bites, loose sutures, absorbable / silk sutures
- Aggravated by intense and prolonged use of steroids.
- Permanent not alleviated by suture removal.

3. WOUND MISALIGNMENT

- Astigmatism located at any axis depending upon location / nature of defect.
- Wound misalignment – Vertical – override – usually corneal steepening. Horizontal alternate areas of wound Compression & wound gape.
- Permanent and not alleviated by suture removal.

4. IOL RELATED (rare)

- Caused by IOL tilt.

- Poor manufacture.

- Rigid lens distortion of limb ring.

- Permanent (Without further surgery)

SOURCES OF POST CATARACT SURGEY ASTIGMATISM

1. **Pre – existing astigmatism**

   The final astigmatic error depends as a large extent on the preoperative astigmatism. Some surgeons attempt to leaving the cornea upto 1.5. D of with the rule astigmatism to enhance contact lens fitting or increase the depth of focus for near vision. Others attempt to correct the preoperative astigmatism during cataract surgery by varying the various surgical factors like incision, suturing or timing of suture removal.

2. **Cautery**

The long term effects of cautery may give rise to unacceptable levels of post operative astigmatisms by two mechanism:

a. Heat induced scleral shrinkage
b. Closure of capillaries & small vessels which affect wound healing process.

Hence cautery should be used sparingly if at all during cataract surgery.

ASTIGMATISM IN SICS

It has been shown experimentally and clinically that if the incision can be kept aborter than 4 .0mm, it is possible to avoid significant induced astigmatism. Various studies have reported that a 3.0mm incision produces about 0.26D against the rule astigmatism while a 4.0mm incision induces a 0.77D & a 5.0mm incision of over 1D of ATR astigmatism. Hence with manual Sics incision which are approximately 6-8 mm in length, it is probably not possible to completely avoid all induced astigmatism. With incision longer than 3.0, 4.0mm, multiple factors are involved and these interactions makes the subject very complex. The various facts include the site of incision, the length of the incision, the plane of the incision, the tissue elasticity, tissue tensile strength and wound health. The various elements of suturing like tightness of sutures, length and depth of suture number of sutures also play a role in cases where the wound requires suturing. The preoperative astigmatism is also deterrent in making of patient emmetropic.

CORNEAL ASTIGMATISM

The corneal astigmatism may be of the following types.

A. Regular astigmatism

Regular astigmatism exists when the principle meridians of the corneal surface are perpendicular to each other. It may be

(i) With the rule astigmatism : Where the steeper meridian is vertical or within 30^0 of the vertical (60^0 to 120^0)

(ii) Against the rule astigmatism: where the steeper meridian is horizontal or within 30^0 of the horizontal (0^0 to 30^0 or 150^0 to 180^0).

(iii) Oblique astigmatism: When it is between 30^0 and 60^0 or between 120^0 and 150^0.

Significantly, induced corneal astigmatism depends on how the incision is created and how it is closed. Separation of wound edges by an incision will result in flattening of the cornea in the axis of the incision leading to an against the rule astigmatism.

B. Irregular astigmatism

Here the astigmatism varies in each point on the corneal surface. It can not be corrected with spectacles & needs rigid contact lenses.

Compounding the various aspects of the external incision (Size, shape and location) which influence the induced astigmatism, PaulS.Koch proposed the concept of incisional funnel. (Described in chapter on wound construction).

Incision characteristic

The following characteristics of the incision affect the post-operative astigmatism

a. Location

Posterior incision: In Manual SICS the incision is made 2-3mm behind the limbus. Which decreases the surgically induced astigmatism. Apart from this it gives a greater wound healing surface and more watertight seal. Disadvantage of posterior incision include greater risk of premature posterior entry and postoperative hyphema.

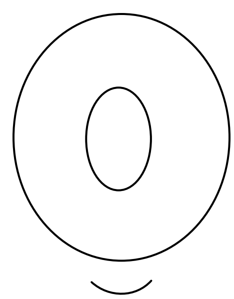
As the cornea flattens along the meridian of the sclera section, incision can be fashioned on the steep meridians of the preexisting astigmatism. In patients with preoperative against the rule astigmatism the temporal site can be preferred. While fashioning temporal tunnel it is advisable to bevel it more anteriorly into the corneal before entering in to the anterior chamber as the cornea is horizontally oval in shape and as such with the temporal limbus is narrower.

Selection of the site for fashioning the tunnel may not be applicable in patients with astigmatism in oblique meridian, because of prominent brow or nose. These cases may require an addition astigmatism keratotomy.

b. Style of external incision

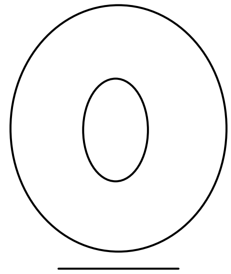
i) Curvilinear incision / 'Smile' incision

Traditional cataract incision have been limbus parallel curvilinear incision. With this incision there is nothing to prevent the inferior edge from falling away from the superior edge. This wound gape potential is the cause for against the rule astigmatism. This induces high astigmatic changes up to 4.0 D WTR cylinder to 2.0 D against the rule cylinder with time. This prolongs the visual rehabilitation of the patient.



ii) Straight incision:

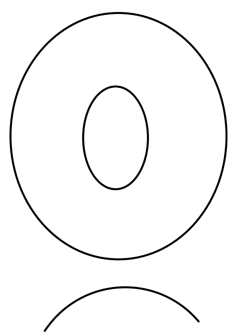
If the incision is straightened, the two extreme points of the incision are secured in the sclera & the inferior edge directly adjacent to these end points of the incision can not sag. So induced astigmatism is limited to the degree of instability of the middle of the incision. This incision induces lesser astigmatism than curvilinear type. A straight incision of smaller length induces less astigmatic change if it is the incisional funnel. A longer incision has to be moved posteriorly to achieve the same effect.



iii) Frown incision

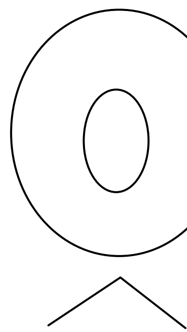
If the ends are placed further superior on the sclera, then the incision becomes even more stable. The superior wound edge acts as though there are slings hanging down which are supporting the ends of the incisions. As a results the inferior edge of the incision would not sag away from the superior edge of the incision. The potential for against the rule astigmatism virtually disappears.

As can be predicted, this incision produces the least amount of astigmatism. In this type of incision, as each edge of the incision is turned backwards, the entire incision falls within the incisional funnel.



iv) Chevron V Shaped incision

It is based on the same principle as the Frown incision. The incision is made in the form of the inverted letter ‘V’. The apex of the V will be near the limbus and the limbus away from it.



Bartow et al have reported the vector analyzing of pre operative and 3 months post operative keratometric result in 30 patients with 5mm Chevron V shaped incisions following mini nucleus ECCE. The surgically induced vector was 0.54D $\pm$ 0.58 D. Pham Di et al used a trapezoidal tunnel incision of 11mm for suture less ECCE. They have reported astigmatism at a rate of 2D, stable within 4 week after surgery and did not change up to 2 years post operatively. The induced astigmatism was reduced to 0.5 D by a radial suture.

c. Length of the external incision

Length of the external incision in SICS will be around 5.5 to 7 mm, it varies with the size and density of the nucleus and the method used to deliver it out of the Anterior chamber. As seen above, the amount of astigmatism is less with smaller incisions compared to longer ones.

Paul Ernest studied the astigmatism induced by 12mm, 7mm, 4mm incisions. At 3 months post operatively, the following findings were observed.

Incisional length	**Induced astigmatism at 3 months postoperative**	**Induced astigmatism at 8 months postoperative**
12mm	3.09D	-
7mm	1.92D	1.32D
4mm	1.05D	0.99D

Yan K. and Jians, JK have used a 6 mm tunnel with manual nucleus division technique in 70 eyes and have reported astigmatism of 0.5 or better in 76.5% at one week post operative. Kimova H et al have used 8.0 mm sclera tunnel incisions for dense cataract and have reported a surgically induced vector of 1.41 D ± 0.72 D with superior incision and 1.02 ± 0.66 D with oblique incision.

d. Effect of sutures

A longer tunnel is usually closed with sutures. From the astigmatism point of view any incision greater than 6.5 – 7mm should be sutured to prevent excessive postoperative astigmatism. Closure of incision with sutures brings the wound edges back together. Most commonly, the sutures are tight enough to compress tissue at wound edges, increasing corneal curvature in the axis of incision there by inducing a with the rule astigmatism. This induced astigmatism is temporary and degrades post operatively. If it fails to reapproximate the edges until secure tissue healing occurs, permanent against the rule astigmatism will result.

For closure of the incision, some surgeons prefer radial sutures. These sutures pull the scleral flap and comes to an unphysiological position and can disturb the internal entry site, which is the astigmatism control site. Therefore radial sutures may cause astigmatism instead of correcting it.

The other method of suturing the tunnel is to place a horizontal suture. The horizontal sutures make the incision watertight and as the vertical vectors are eliminated it gives a more physiological closure. The another advantage of horizontal suture is that it is less prone to disturb the internal entry site and hence causes less astigmatism.

Haberle H, Anders N, et al studied on 250 eyes with suture less (N=70), with a single perpendicular suture (N=100) or cross suturing (N=40) at the 12^{o} clock position or suture less in the temporal position (N=40). Late mean astigmatism up to 3 year up for vertical incision was 2.05 ± 1.16 D (1.01± 0.96D Preopertively) for sutureless wound closure, 1.63 ± 1.08 D (0.86 ± 0.95D) for perpendicular and 1.76 ± 0.88 D (0.73 ± 0.55D) for cross sutures. A temporal incision resulted in 0.75 ± 0.52 D (1.0 ± 0.69 D) of astigmatism.

e. Size of the internal entry

When an incision is made on a sclera surface, it is common to see the two edges separate from each other. This is a physiological reaction to two factors – the natural elasticity of the sclera and sclera shrinkage from cautery. The incisional gape does not affect corneal astigmatism. If a sclera incision was made and an incisional gape resulted, but then the operation was halted – no astigmatism would result. If we were to continue the tunneling, but stop before entering the anterior chamber, again there will be no net effect on astigmatism. Only if we continue the incision and enter the anterior chamber can we have changes in corneal Astigmatism. Through and through entry in to the anterior chamber permits the cornea to change shape.

Thus the size of the internal opening is very crucial for induced corneal astigmatism.

Even though the size of the external incision is only 6mm or less in a majority of cases, the reason of higher incidence of astigmatism is due to the wider internal entry, which may be the main cause.

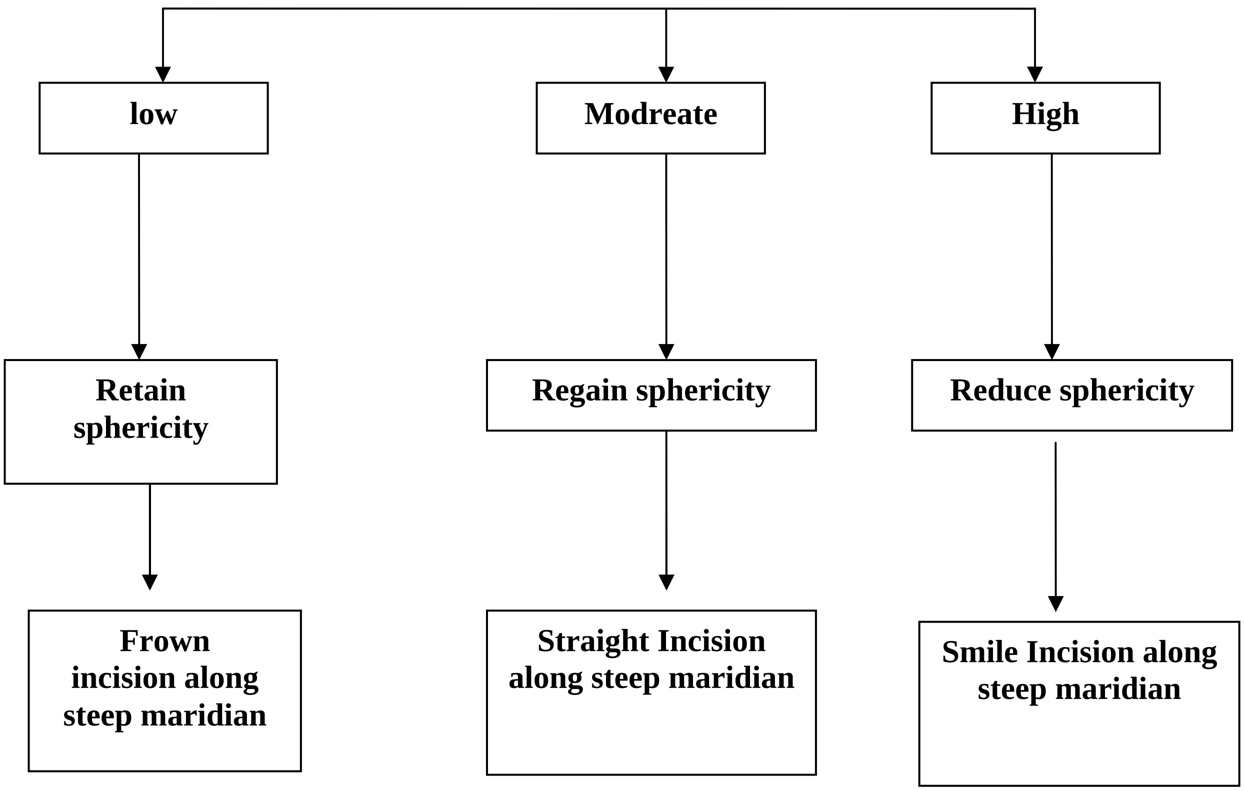
In Manual SICS, the length of the internal opening is approximately 1 mm longer on either side of the incision compared to the external opening. Thus a 6 mm external would will actually have an 8 mm internal opening which may explain a slightly higher astigmatism seen with small incision ECCE.

Manual SICS in Preexisting Astigmatism

A scleral pocket incision can be used to correct or reduce the existing preoperative astigmatism, when low preoperative astigmatism is encountered, the incision is made in the astigmatically neutral funnel with ‘frown’ shape at the steeper meridian. In higher degree of astigmatism, a ‘Smile’ incision can be made along the steep meridian closer to the limbus. These patients may need additional astigmatic keratotomy to fully correct the astigmatism. (Refer flow chat)

Criteria for selecting the site of tunnel construction according to the Pre-existing astigmatism

Any Preoperative Astigmatism



PHACOEMULSIFICATION

Basic Features:

Every phaco machine has three basic function. These are irrigation, aspiration and ultrasonic fragmentation. Correspondingly following instruments are used.

1) Irrigation – Aspiration Hand piece
2) Ultrasonic hand piece
3) Phacotip
4) Phoco parameters

Aspiration Pumps:

Depending on the machine, three kinds of pumps are used to control aspiration and produce negative suction pressure i.e., the vacuum. They are

1) Peristalitic pump
2) Venturi pump
3) Diaphragmatic pump

The peristalitic pump is also known as a “constant flow” while the venturi and diaphragmatic pumps are “constant vacuum” variety.

Foot Pedal:

The position indicator shows the mode of operation in which the instrument is functioning on depressing the fool pedal in a linear manner.

Position 1 : Only irrigation solution is flowing.

Position 2 : Irrigation and aspiration flowing

Position 3 : Irrigation, aspiration and fragmentation takes place simultaneously.

Mechanism of action of Phaco:

Factors involved include:

A) A mechanical impact of the tip against the lens.

B) An acoustical wave transmitted through fluid in front of the tip

C) Cavitation

At the cessation of the forward stroke, the tip has imparted forward momentum to the fluid and the lens particles infornt of it, on the tip being retracted, the fluid cannot flow, thereby creating a void infront of the tip. The void is collapsed by the implosion cavitation of the tip thereby creating additional shock waves.

D) There is an impact of fluid and lens particles being pushed forwards infront of the tip.

PHACO PARAMETERS

Ultrasound power

The ultrasound power is usually about 50% to 70%. If the lens is soft it isdecreased to about 30% and if it is hard, power is increased to 80% to 90%.

Effective Phaco Time:

It is the total Phaco time at 100% Phaco power. Effective Phaco time is very significant, as the less effective Phaco time indicates proportionately less energy delivered to the eye thereby reducing the side effects of Phaco power.

Phoco Power:

Phaco power is the ability of the Phaco hand piece to cut and emulsify cataract. Phaco power is directly related to stroke length, frequency and efficiency of hand piece.

Stroke Length:

Stoke length is the distance by which the titanium Phaco tip moves to and fro. It is the most important factor in deciding the Phaco power. Changing the Phaco power setting of the machine can alter the stroke length.

Frequency:

Frequency is the number of times the tip moves and is fixed for a particular Phaco hand piece, it is measured in KiloHz's. The power variables are adjusted intra operatively and it depends on:

1. Density of nucleus where Phaco tip engages.
2. Amount of tip engaged.
3. Linear velocity of the tip during emulsification.

Wound construction in SICS

SICS has distinct advantages over other forms of surgery in terms of wound stability, reduced surgical trauma and associated complications, minimal astigmatism and early rehabilitation. The principles of cataract wound construction need to be studies to understand these advantages.

The Incisional Funnel

This is a concept postulated by Paul Koch. It deals with certain characteristics of self sealing incisions like length and external configuration that impact not only self stability but also astigmatism neutrality to these incision. Mechanism of external incisions can be understood if we consider that astigmatism is inversly proportional to the distance the incisions is placed from the limbus. The composite relationship between astigmatism, incision length and distance from the limbus can be projected onto the ocular surface, producing the so called incisional funnel. It consists of an imaginary pair of curved lines representing the outer limits of scleral incisions that produce the same amount of astigmatism. These lines diverge outwards from the limbus, separating as the distance form the limbus increases. Incisions made within this funnel will, for all practical purposes be astigmatically neutral. Accordingly short incisions made closer to the limbus and longer ones further away, all will have the equivalent effect on corneal curvature.

A. Superior Approach of the Scleral Tunnel

A clear understanding of the following components of the scelral tunnel have an important bearing on the technique of small incision cataract surgery.

1. **The Length:** The length of the sclera tunnel is defined as the distance between the ends of the incisions measured along the contour of the incision.
2. **The Width:** the width has been defined as the perpendicular distance from the scleral groove to the line of entry into the anterior chamber. It is found that when the external groove is placed as far posteriorly as possible, induced astigmatism is minimal. The posterior limit from the anterior limbus is 4mm. It is important to remember that the induced astigmatism produced by a scleral tunnel incision of a given length is inversely proportional to the surface area of the flap.
3. **The Depth:** The depth is defined as the thickness of the flap. The optimal depth for the sclera flap incision is 0.2 – 0.3 mm, which can be accurately measured using a guarded, calibrated diamond knife held perpendicular to the sclera surface for the initial grove. With practice the same sclera flap may be achieved with a regular crescent blade. Very thin sclera flaps may cause two problems. First, they have a tendency to tear with manipulation and second, the induced astigmatism will be high due to the slippage of the

sclera flap. With thicker flaps there is a higher risk of premature entry and a thin internal corneal lip predisposing to hyphema.

The construction of the sclera tunnel consists of the following steps:

1. External scleral incision
2. Sclero corneal tunneling
3. Internal corneal incision into the anterior chamber.

External Scleral Incision

A fornix based conjunctival flap of size corresponding to the length of the tunnel is made. Tenon's capsule can be cut along with the conjunctiva or separately. Only light cautery should be applied to avoid scleral shrinkage and the resultant astigmatism. A one-third to half thickness external scleral groove is made 2.5 to 3 mm from the surgical limbus. It may be limbus – parallel, linear, or frown-shaped. Instruments that are commonly used for making the external groove are razor blade fragments or a #15 surgical knife or crescent knife or a guarded diamond knife. The length of the external sclera incision depends on nucleus density. Usually an external scleral groove of 6 – 6.5 mm length is made.

Sclero – corneal tunneling

The actual tunneling is done with a bevel-up crescent blade. It should be uniform in thickness and extended up to 1-1.5 mm into the clear cornea. During tunneling within the sclera, the forward surface of the blade should be just visible. If it is very clearly visible, then the tunnel is superficial and if it is barely visible, the tunnel is too deep. During tunneling one should raise the tip and depress the heel of the blade to prevent premature entry into the anterior chamber.

Side port Entry

One side port entry is usually made using a 15 super blade at the 1'o clock position or perpendicular to the tunnel, in the clear cornea. The stab entry is done parallel to the iris and 2mm wide. Most surgeons prefer to perform their capsulorhexis through the side port entry. The other purposes include:

1. Aspiration of the sub-incisional cortex
2. Reformation of the anterior chamber at the end of the surgery.

Through the side port entry viscoelastic is injected to make the eye ball firm to allow easy entry of the keratome blade. It also helps in completion of the extension of wound as the anterior chamber is entered.

Internal corneal incision

This is done using a sharp 23.2 mm angled keratome. The heel of the keratome is raised until the blade becomes parallel to the iris plane resulting in a dimple on a corneal surface. The keratome is then advanced anteriorly in the same plane until the anterior chamber is entered and the internal wound is visualized as a straight line. During extension of the incision, care should be taken to keep it in the same plane. The extension may be made using the same keratome or a 5mm keratome.

Advantages of Scleral Tunnel

i) Expulsive choroidal hemorrhages can be managed by simply closing the wound by injecting saline through a side port incision.

ii) Respiratory or cardiac incidents can be managed by removal of the instrument, resuscitating the patient and continuing the surgery once the patient is stable.

iii) All suture related complications like induced astigmatism, foreign body sensation, suture bleb formation can be avoided.

iv) A stronger wound that permits a greater range of post-operative activities such as bending, lifting, resuming sports, and even rubbing the eye on the first post – operative day.

B. Temporal Approach of Scleral Tunnel

In manual SICS, the following situations are tackled better with temporal scleral tunnel approach. The conditions are:

1. Preexisting against the rule astigmatism
2. Presence of superior filtering bleb
3. Secondary procedures where previous surgical maneuvers have left behind scarred conjunctival tissue superiorly. Eg. Aphakic eyes requiring a secondary intraocular lens implantation, intraocular lens exchange cases.
4. In extremely deep sockets where superior tunnel construction and other manipulations are difficult to carry out.

Technique

The principles and techniques of tunnel construction are the same as have been described earlier. The orientation of the microscope and the surgeon are shifted on towards the temporal side of the eye that is to be operated. Since the surgical limbus has width of only 0.4mm in the horizontal meridian, lamellar dissection into the cornea should be more anterior in order to get a better valve effect of the self incision. The side port entry is made more inferiority as 7^0clock position. The vessels should be well cauterized.

Advantages of a temporal tunnel

1. A lesser against the rule drift is present in – patients with a temporal tunnel due to various reasons. First, an against the rule astigmatism predominantly exists in the cataract age group and is further increased with an incision at $12^{0'}$ clock meridian. Next, the eyelid pressure emphasizes the against the rule shift with a $12^{0'}$ clock incision in the elderly population. Due to the eliptical cornea and the incision at $12^{0'}$ clock would be closer to the centre of the cornea than the temporal incision, which would be more neutral astigmatically.
2. A temporal location enables a better working space than a superior approach due to the absence of the hindering effect of brow especially in cases of deep sockets.
3. The globe being parallel to the axis of the microscope, the red glow is better appreciated from the temporal side providing better visibility.

The main disadvantage of the temporal approach is that the surgeon may take time to get oriented to the new working position.

B. Continuous Curvilinear Capsulorhexis

Is the ideal and preferred type of capsulotomy. There are several advantages of a capsulorhexis.

a. It ensures a permanent, verifiable and secure fixation of ‘in the bag’ IOL implantation.
b. The absence of anterior capsular tags or remnants ensure a safe and easy aspiration of peripheral cortex, which is further expedited by a thorough hydrodissection.
c. Minimal trauma to the zonules is exerted while performing this technique
d. In case of a posterior capsular rupture, it provides a good support for the sulcus fixation of intraocular lens implant.
e. Presence of a visible anterior capsular rim helps in carrying out polishing of the anterior subcapsular epithelial cells and thus preventing posterior capsular opacification later on.

Technique

A bent 26 G needle / cystitome is used to make a capsulorhexis through either the main tunnel or side port entry. The latter approach is good in cases of deep sockets. With the tip of the bent needle, an initial puncture is made in the centre of the capsule and the cut extended horizontally to the right and then turned to the left to create a flap. The tip of the needle is used to redirect the flap anticlockwise. By exerting gentle traction with the needle to on the flap, it is pulled along in a circular motion to achieve a round rhexis margin with the last part of tear joining the first part form the outside towards the centre. Conversely, if the tear is joined from centre toward the periphery, it will create a triangular flap, which can tear towards the equator of the lens. Throughout the procedure the direction of the tear should be controlled by directing the tip of the needle to the centre in the 'rip' manoeuvre or concentric to the pupil in the 'shear' technique. On peripheral extension of the tear the chamber is reinflated with viscoelastic material and the tear pulled to the centre at an acute angle by giving a light touch to the flap.

3. Hydrodissection and Hydrodelineation:

Hydrodissection: the infusion fluid is injected exactly between the anterior capsule and the cortex.

Hydrodelineation: here the infusion fluid is injected between the epinucleus and the nucleus.

4. Phacoemulsificaton by Divide and conquer:

Divide and conquer is the most commonly practiced technique for emulsification.

Four quadrant cracking:

This method is the modification of the technique originally described by John Shepherd.

After trenching of the nucleus, the nucleus is cracked into four fragments. The first fragment is engaged and emulsified by Phaco tip followed by other three fragments. After the removal of the nucleus, the epinucleus and cortex are removed.

The Phaco chop technique:

Nagahara described this technique. This technique utilizes a chop to divide the nucleus by mechanical energy thus eliminating the need of trenching thereby increasing the safety margin in phaco surgery.

Surgical technique:

Phaco chop can be performed with both clear corneal and sclera tunnel incision. Construction of the incision is same as for the other emulsification procedures except for placement of the site port which is placed closer to the 1'o clock just at the left edge of the tunnel incision. A vertically oval capsulorhensive is preferred. Hydrodissection and hydrodelineation are then performed.

Phaco probe is placed in the anterior chamber and superficial cortex and the epinuclear plate is removed to make the nucleus bare. The chopper is then placed in the anterior chamber and the nucleus is slightly nudged down. The nucleus is subsequently impaled into the phaco tip at 12o clock to hold it. A high vaccum setting in combination with high phaco is recommended. The chopper is next passed below the capsule and the epinuclear plate. The chopper is inserted horizontally sliding on the bare nucleus. Once it crosses the cleavage plane between the nucleus and the epinucleaus it is rotated to make it vertical that is the position in which the chopping action can be initiated, placement of the chopper is very important as its positioning and movement decides the chopping. It is recommend that the chopper be placed slightly to the Right of 6’o clock position. The chop is then moved towards the probe to initiate cracking and after the initial cracking both the instruments are moved laterally in opposite directions dividing the nucleus into two halves. The nucleus is then rotated through 90^0 phaco tip again impaled into the lower half and the half is chopped into the quadrants or more as desired. It is preferable to chop each half into three or more fragments. Each of these pieces is then engaged into the phaco port with the aid of the chopper. It is preferable to engage the apex of the quadrant to be emulsified to reduce the incidence of inadvertent chattering or tumbling of the fragment. The entire fragment is emulsified using low phaco and high vaccum. The upper half is then rotated into the inferior quadrant, chopped into smaller pieces.

E. Extension of Phaco Incision

The extension is done using a blunt tipped extension keratome. The size of the keratome should equal the diameter of IOL optic that needs to be implanted through it or required size for the foldable design.

F. Closing of Phaco Incision

The capsular bag is inflated using Viscoelastic, followed by implantation of IOL. The Viscoelastic is removed from the chamber and in turn inflated with the irrigating fluid. The high pressure inside the chamber forces the two lips of internal opening against each other and closes them.

MANUAL SMALL INCISION CATARACT SURGERY

Advantages of phacoemulsification were well documented but there were inherent disadvantages like danger of trauma to the endothelium (especially in the early stages of learning curve) and the fact that it was not applicable to all cases for example, hard nuclei. The relatively high expenses involved and constant breakdown of the equipment put further constraints on its further wide spread use.

Conventional extra-capsular cataract extraction on the other hand had the disadvantages of large incision, greater postoperative astigmatism and slower rehabilitation.

Keener conceived a less complex means of accomplishing the nucleus division. This involved passing a wire loop around the nucleus after first displacing it into the anterior chamber. The loop once around the nucleus could be constricted thus dividing the nucleus. Once sectioned, nucleus halves could be removed by sliding them out with a narrow lens loop. This method had the virtue of requiring only simple, readily available instruments.

In November 1983, for the first time the lens was removed through 6.0 mm incision without the use of Phacoemulsification.

Equipments

In addition to standard instruments required for extra-capsular procedure two instruments are require for the nucleus division technique. The first is the nucleus divider which consists of a cannula and a 32 gauge stainless steel wire formed into a loop. The second is a narrow lens loop. Used for removing the two pieces of nucleus generated by division.

The basic steps of manual SICS are:

The basic steps of Manual SICS are very similar to those of phacoemulcification. Only the step of removing the nucleus is different from phacoemulsification. In manual SICS the nucleus is prolapsed into the anterior chamber and removed by hydro expression, whereas in phacoemulcification the nucleus is broken into pieces emulsified and removed within the eye.

1. Sclero - Corneal tunnel constructions

    a. Superior approach

    b. Temporal approach

2. Capsulotomy

The type of capsulotomy required is manual SICS, unlike phacomulcification can be either a canopener or continuous curvilinear Capsulorhexis.

Canopener Capsulotomy

In any form of extra capsular cataract surgery, capsulorhexis is ideal as it Facilitates implantation of the IOL in the bag. However, in the following situations Canopener capsulotomy may be employed in Manual SICS.

a. Those who are yet to master the art of making a capsulorhexis, can start with canopener capsulotomy as SICS can still be done through canopener capsulotomy.
b. Even while learning capsulorhexis, conversion to a canopener capsulotmy can be made at any stage following peripheral extension of capsulorhexis.
c. In certain situations where capsulorhexis is difficult like :-
    1. Mature cataracts
    2. Small pupil
    3. Calcified or fibrosed anterior capsule
    4. Cases of Grade III and Grade IV nuclear sclerosis. In these cases a can opener capsulotomy is preferred to a capsulorhexis. It facilitates an easy prolapse of the hard nucleus into the anterior chamber.

Technique

The capsulotomy is preferably done under viscoelastics so as to minimize the damage, to the endothelium. It also prevents the anterior capsule from spontaneously curling. A new sharp cystitome of a bent 26 G needle should be used for each case. Either multiple, radial cuts or punctures as in a postage stamp can be done. Multiple small tears are preferred to avoid capsular tags.

Capsulotomy is made either in clockwise or anticlockwise direction, approximately, 15, 20 punctures are made per quadrant avoid cutting into and stripping zonular attachment. Tears are made circumferential to the equator or to avoid damage to the zonular insertion. Restrict the size of the capsulotomy to 6.5mm.

3. Hydroprocedures & Prolapse of Nucleus into the Anterior Chamber:- When changing the technique from large limbal incision cataract surgery to small incision surgery a beginner faces a few hurdles. These are essentially caused by certain steps which one have never done before. After making the scleral tunnel and capsulotomy the surgeon confronts the challenge of getting the nucleus into the anterior chamber.

The technique of nucleus prolapse into the anterior chamber depends on the type of capsulotomy done. The two types of capsulotomies most commonly practiced are the canopener and the continuous curvilinear capsulorhexis.

1. Techniques associated with a capsulorhexis

The first prerequisite is an adequate sized rhexis which should be 5.5-6 mm or more depending on the size of the nucleus. A large capsulorhexis can be active by using the side port entry site to introduce the cystitome.

Hydroprolapsing method

Good hydrodissection and hydrodelineation are a prerequisite. Good hydroprolapse is a two-step procedure. One is to inject fluid and the second is to press downwards while injecting with the canula. The combination of mechnical and hydrostatic forces causes the opposite pole of the nucleus to pop out of the capsulorhexis margin. The rest of the nucleus can be dialed out of the bag easily. In softer cataracts, the whole nucleus can be tumbled out of the bag with the cannula while doing hydrodelineation. If the nuclear hardness is estimated correctly preoperatively, no relaxing cuts are required for the capsulorhexis as it is only the endonucleus which comes out. Even if the rhexis turns out to be slightly smaller, the nucleus can be safely prolapsed out by the bimanual technique.

2. Techniques used with canopener capsulotomy

A. Mechanical Method:

With canopener capsulotomy there is no need for any of the hydro procedures and the nucleus is mechanically prolapsed into the anterior chamber with the help Of a Simskey hook. The superficial loose cortex is first washed off exposing the firm nucleus underneath. The nucleus is then impaled either with a cystitone or a Sinskey hook at the 12 o'clock position at a point just within the capsulotomy margin. The nucleus is then pushed down towards 6 clock. This ensures that superior equator of lens clears the pupillary margin. The instrument is then lifted up and rotated so that superior pole of nucleus gets prolapsed. This movement would be akin to lifting a piece of fruit with a fork. In some cases, making to and fro rotations clockwise and anti-clockwise before lifting may help in severing some of cortical adhesions. Some surgeons find it easier to engage the nucleus at the 9'o clock position, Once one pole is out, the rest is relatively easy. The equator of the nucleus is engaged and the nucleus is rotated either clockwise or anticlockwise or in both directions, till it comes to lie entirely over-the iris. The nucleus usually rotates easily because of a shearing force created in between the fixed posterior capsule below and the hard nucleus above without putting in due stress on the zonules.

B. The small pupil approach:

An intra-operatively constricted pupil is a nightmare for any surgeon. In small incision cataract surgery one is faced with the daunting task of getting the nucleus out through this small pupil into the anterior chamber. One option is to enlarge the pupil. This can be done pharmacologically by using intracameral adrenaline. Using NSIAD drops like Flurbiprofen or Ketorolac drops preoperatively also helps. One can also resort to procedures like stretch pupilloplasty with Kuglen’s hooks or sphincterotomies. In certain high risk cases like psuedoexfoliation with a small rigid pupil and an associate hard nucleus it would be prudent to go in for a small sector iridectomy or key hole iridectomy in case of a pliable small pupil and ones aesthetic sense does not allow one to mutilate the pupil, there is still an alternative, namely what we have termed the bimanual technique:

C. Bimanual Technique:

Here two instruments are used. One is a Sinskey hook in the right hand and the other a cyclodialysis spatula in the left. This technique is useful if one has failed to prolapse the nucleus by the mechanical method or in case of a small pupil.

As described before, the Sinskey hook is embedded in the nucleus and pushed towards 6'o clock. Once the superior pole of the nucleus is visualized the cyclodialysis spatula is inserted under it. The second instrument can be passed through the main wound itself or through the side port entry site. The pole in then tipped up with the spatula. The nucleus is dialed out by repeatedly engaging the equator with the Sinskey hook. The role of the spatula is not only to tip out the superior pole but also to act as a support to the capsulotomy margin and pupilary margin on one hand and the nucleus on the other. It also acts like fulcrum over which the nucleus is rotated out.

Potential complications of the bimanual technique are, nuclar dialysis, indodialysis, endothelial damage and rarely nucleus drop.

3. Nucleus Extraction

Once the nucleus is prolapsed into the anterior chamber, is can be extracted through the tunnel by the following methods as are discussed below:

- Irrigating vectis method
- Phaco sandwich technique
- Phacofracture technique
- Bluementhal technique

Nucleus extracts with an irrigating vertis

This is a very simple technique of small incision ECCE first described by Steiners. This technique basically uses a combination of mechanical and hydrostatic forces to express out the nucleus. It is time - tested proven technique which gives excellent results.

Instrumentation

We use an irrigating vectis. This is available in various shapes and sizes. We prefer a 5 mm wide vectis, with one to three 0.3 mm forward irrigating ports with a gentle superior concavity. This vectis is attached to a 5 cc syringe containing ringer lactate / BSS when in use.

Surgical Technique:

After prolapsing the nucleus into the anterior chamber viscoelastics are liberally injected both above and below the nucleus. The upper layer shields the endothelium while the lower layer pushes the posterior capsule and iris diaphragm posteriorly. This creates space for the atraumatic insertion of the vectis. A proper superior rectus bridle suture is crucial for the success of this step. An improper bridle suture will produce difficulties in extracting the nucleus. The superior rectus suture is loosely held in the left hand or the assistant is asked to hold it, The vectis is now tested out side for the patency of the ports. Once confirmed it is then insinuated concave side up, under the nucleus. One should again confirm and make sure that one can see the margins of the vectis through the nucleus. This is possible in most cataracts except very white and very black nuclei. Now the following movements should occur in synchrony. The superior rectus is pulled tight and with the globe thus fixed, the irrigating vectis is withdrawn out slowly without irrigating till the superior pole of the nucleus is engaged in the tunnel. The irrigation is now started and the vectis slowly withdrawn out while pressing down on the scleral lip. These steps are crucial in protecting the endothelium. The irrigation keeps the anterior chamber well formed whereas the downwards pressure also helps to prevent the nucleus rubbing on the endothelium. The force of irrigation has to be reduced when the maximum diameter of the nucleus just clears the tunnel. The step prevents the nucleus being thrown out forcefully with a consequent sudden decompression and shallowing of the anterior chamber.

B. The phaco sandwich technique

Introduction

Luther L.Fry first attempted the phacosandwich technique in 1985. He was actually trying to bisect the nucleus inside the anterior chamber. For this he was using a standards lens loop and an iris spatula. In the process, he discovered that by squeezing the nucleus between these two instruments, it could be extracted through a smaller wound, leaving the softer peripheral nuclear and cortical material in the eye for later aspiration. The incision size he used was a 7.5mm, we usually use incisions varying from 5.5 – 6.5mm. However, black nuclear cataracts require 6.5 - 7 mm long tunnels. Thus, the size of the tunnel depends on the size of the nucleus. Any tunnel longer than 6.5 mm should be sutured.

Instruments

The instruments we use for the phacosandwich technique include a vectis (solid or irrigating) and a Sinskey hook.

Surgical Technique

Once the nucleus is in the anterior chamber, a viscoelastic is injected between nucleus and endothelium. This is done to give adequate space for introducing the second instruments, the Sinskey hook, and preventing the endothelium from being damaged. Additional viscoelastic is placed between the posterior pole of the nucleus and the posterior capsule. Thereby the iris and posterior capsule are retrodisplaced, giving adequate space beneath the nucleus for introducing the irrigating vectis. The curved vectis measuring approximately 5 mm at its greatest width and approximately 8mm in length is now introduced underneath the nucleus. The vectis should be allowed to find its own plane and should not require any force for positioning. Once the vectis is in position, the Sinskey hook is carefully placed on top of the nucleus, sandwiching it between vectis and Sinskey hook. The tip of Sinskey hook is placed beyond the anterior pole of the lens to get a better grip using a two-handed technique. With the Sinskey hook in the dominant hand and the vectis in the other, the nucleus is sandwiched and extracted. While doing nucleus extraction, the assistant should pull on the superior rectus suture. This will ease the procedures as well as prevent the anterior chamber collapse following nucleus delivery.

The outer portion of the nucleus, the epinucleus and a portion of the cortex will be sheared off with the phacosandwich technique. The shearing force is originating from the lateral edge of the internal opening, not from the endothelial surface. It would be difficult to aspirate the mixture of viscoelastics and epinucleus debris with the help of a Simcoe canula. Rather, this epinucleus sludge can be removed with the irrigating vectis. The irrigating vectis is placed beneath the epinucleus material floating in the anterior chamber. Fluid is slowly injected and the bridle suture pulled simultaneously with the other hand thus expressing the epinucleus and other cortical material. Many surgeons prefer the viscoexpression technique for the removal of epinucleus because the fluid curtain produced during the former technique can cause endothelial damage. In this technique viscoelastic is injected at the 6'O clock position to fill the anterior chamber and to inflate the capsult bag. The epinucleus is then expressed by applying pressure on the bridle suture and depressing the posterior lip of the tunnel.

C. Phacofracture technique

Introduction

A small incision has distinct intra operative and postoperative advantages. Phaco emulsification permits surgery through openings down to 5-5.5mm to accommodate a non-foldable posterior chamber lenses. The foldable intraocular lenses allow further reduction of incision size.

Phacofracture is the manual nuclear fragmentation for removing the large nucleus through a small incision. Peter Kansas introduced the technique. He bisected the nucleus in the anterior chamber using a sharpened cyclodialysis spatula.

- Bisector technique
- Trisector technique
- Phacosalute and fracture
- Wire-loop technique
- Phacofracure at the exit

i. Phacofracture with a bisector

Instrumentation

Includes a bisector sinskey hook and the vectis.

Surgical technique

As in the phaco sandwich technique, the safety and effectiveness of the technique depend heavily on the usage of viscoelastic. The technique can be performed through a tunnel of 4.5-5.5 mm in length. A, solid curved vactis, approximately 4mm at its greatest width and approximately 8mm in length is insinuated under the nucleus after injecting viscrelastic. The bisection is now carefully introduced and positioned on the anterior surface of the nucleus. The two instruments are maneuvered towards each other. The bisector will gradually cleave its way through the nuclear substance and stop when it comes into contact with the vectis. This is a very gently step. Steadily and constant pressure on the bisector and gentle lifting pressure with the vectis will easily split the nucleus. With proper positioning of the two instruments, on the fragment is Sandwiched and the sandwiched fragment is brought out. The anterior chamber is then reformed with viscoelastics. Viscoelastics are used into only to deepen the anterior chamber but also to reposition the remaining fragment centrally so that it can be more readily grasped. The second fragment is then retrieved and extracted from the anterior chamber. Extraction of the epinucleus and cortex aspiration is done as described in the previous chapter.

ii. Nucleus Trisector Technique

This technique is based on the principle of sectioning the nucleus in the anterior chamber into three small pieces before delivering them out one by one.

Instrumentation:

A solid vectis which acts like a cutting board. A trisector which is commercially available, consisting of a tip having two longitudinal limbs sharp inferiorly.

Technique:

The nucleus having been prolapsed in the anterior chamber is covered liberally with viscoelastics. The nucleus should literally float in the anterior chamber. The solid vectis is now insinuated under the nucleus taking care that it does not go under the iris. The trisector is passed over the nucleus again keeping well away from the endothelium. The trisector is then pressed downwards towards the vectis cutting the nucleus into three pieces. Each piece can then be extracted out with the help of serrated forceps or by the sandwich technique.

iii. Phcosalute and Fracture

The procedure essentially consists of an adequate hydrodissection and prolapsing the equator of the lens anteriorly either at 3 or 9'o clock position mechanically by applying counter pressure at the opposite quadrant. The lens now lies vertically aligned, it in the 12-6' 'o clock meridian, part of it being within the bag and part of the in the anterior chamber. The superior portion of the lens is then amputed or pinched off using a capsule forces and is then expressed using an irrigating vectis.

iv. Phaco fracture with a wire loop

The technique was introduced by Gerald Keener in 1983. He designed a nuclear snare which resembled and functioned quite like a tonsillar snare. He basically made it from a 18-19 guage blunt tipped needle and a 32 gauge stainless steel wire. After prolapsing the nucleus into the anterior chamber the wire loop in positioned around the nucleus. Viscoelastics are used liberally. The keep is now shortened by pulling it back. This causes the loop to cheese wire through the nucleus and divide it into two. Each piece can then be delivered out one at a time with the help of forceps. More number of pieces can be made if the nucleus is large, we do not have much experience with this technique.

v. Phacofracture at the Exit of the Tunnel

After a good hydrodissection, the nucleus is mechanically nudged into the anterior chamber. With the help of an irrigating vectis the prolapsed nucleus is delivered and in the process it is fractured at the exit of the tunnel. The nuclear half that remains inside the tunnel is pushed back into the anterior chamber with visco elastic material, aligned along its long axis, perpendicular to the tunnel, and then extracted with the irrigating vectis out of the tunnel

D. Blumenthal mini-nucleus technique:

This technique is based on very sound principles and is known to give very good results.

Principle

a. An anterior chamber maintainer (ACM) system is used. The advantage of the ACM is that it constantly maintains a positive intraocular pressure during surgery. The eye is thus maintained in a physiological state. Besides, the force of this fluid flow is primarily responsible for the extrusion of the nucleus. The fluid flow also keeps the anterior chamber clear of cortex, blood, pigment etc, so that there is excellent visibility.

b. The length of the incision is equal to the size of the endonucleus.

Surgical Technique:

Two small beveled entries are made in the cornea in addition to the scelral tunnel. For example in a right eye, one is 1.5mm long placed between 5 to 7'o clock inferiorly. The ACM is screwed into this port being attached to a bottle of BSS. The other port is 1mm wide placed at 11'o clock for the entry of various instruments. A capsulorhexis capsulotomy is done, the fluid flow being stopped during this step. Now a good hydro dissection and delineation is done. The bottle height being 50-60cm from the table. The nucleus is brought into the anterior chamber by mechanical nudging with the hydro dissection cannula. In most cataracts the size of the endonucleus is between 5-6mm and hence the scleral tunnel of the same size is constructed. The inner wound is kept larger than the external incision.

During extraction the bottle height is raised to between 60-70cm. a plastic glide 3 to 4mm wide, 0.3mm thick and 3 cm long is inserted under the nucleus. The nucleus is lodged in the tunnel. Now external scleral pressure is applied downwards and the nucleus extracted out.

E. Implantation of IOL into the bag and wound closure

Indications for Manual SICS

- Nearly a universally applicable procedure.
- Hard nucleus.
- Posterior polar cataract.

- Conditions of altered ocular rigidity.

(e.g) Following procedures like scleral buckling and vitrectomy

- Iris coloboma.

Difficulties encountered

1. Problem in prolapsing the nucleus.
2. Dialysis of the posterior capsule.
3. Tearing of the posterior capsule.
4. Dialysis of the iris.
5. Difficulty in extracting the nucleus half.
6. Transient corneal edema.
7. Managing retained nuclear fragments.

AIM OF THE STUDY

To compare the Total Late Postoperative Astigmatism of patients undergoing Phacoemulsification with patients undergoing Manual SICS.

MATERIAL AND METHODS

This study was conducted at Madurai Medical College, Depart of Ophthalmology, Madurai from 2008 – 2009 July. It is a Randomised retrospective study. A total of 100 cases were enrolled in to the study. Two experience surgeon who were well versed with two cataract extraction procedures operated the cases in the period of 2007 – 2008. For all the patients, eyelashes were clipped, received hourly antibiotic drops, oral acetazolamide 250mg was given in the previous night and taken of the surgery next day. Patients who underwent Phacoemulsification were discharged on the 1st post operative day. Patients who underwent Manual SICS were discharged on the second postoperative day.

Inclusion Criteria:

1. Age related cataract
2. Patients with no systemic illness
3. Patients without any corneal abnormalities that would affect astigmatism.
4. Patients with no other cause for defective vision, other than cataract.
5. Patients with no history of previous ocular surgery.

Exclusion Criteria:

1. Traumatic and other complicated cataract
2. Patients with systemic illness
3. Patients with defective vision other than cataract

End points to be measured at discharge:

1. **Preoperative – Uncorrected visual acuity (UCVA)**
    - Best corrected visual acuity (BCVA)
    - Keratometry
2. **Postoperative – Six months**
    - Uncorrected visual acuity (UCVA)
    - Best corrected visual acuity (BCVA)
    - Keratometry

I. History and general examination

The Name, Age, Sex, Date of Admission, Operation and discharge was recorded. History regarding the development of cataract was noted. Any past history of operation in either eye was noted.

A general physical examination was carried out.

II. Examination of the eye

A detailed examination of the eyes was done in every case. Visual acuity was recorded both with and without glasses. A Snellen's chart with good illumination was used for this purpose. In case of illiterate patients, the 'E' Chart was used to record the visual acuity. The patient was made to read the chart at 6 meters uniocularly. If he was unable to appreciate the letters at this distance he was moved closer to the chart until he was able to appreciate the top most letter. If he was unable to do the test his ability to count finger was determined. In case of mature cataract, perception of light and projection of rays were tested. In all other cases fundus was examined by direct / indirect ophthalmoscope.

Visual acuity was recorded in all cases preoperatively and postoperatively and on follow-up at six months.

III. Refraction

This was done with the retinoscope using a plane mirror at a distance of 1 meter. Retinoscopy findings and subjective correction were recorded. The spherical and the required cylindrical correction were recorded.

Preoperative refraction was done in all cases. Postoperatively it was performed on follow-up at six months.

IV. Anterior Segment Examination

All cases underwent detailed anterior segment examination under slitlamp biomicroscopy. A careful examination of the lids, orbit, conjunctiva and cornea was done in every case and positive findings were recorded. Anterior chamber depth was recorded. Iris was examined and any abnormality was recorded.

The site, shape and the reaction of the pupil were recorded. The presence of cataract along with its maturity was noted.

Intraocular pressure was measured in all cases preoperatively using a schiotz tonometry.

V. Fundus Examination

A detailed fundus examination was done with the direct/indirect ophthalmoscope. It was done postoperatively whenever possible and preoperatively in all cases. Any patient with fundus pathology detected were discarded from the study.

VI. A – Scan biometry - was done in all patients preoperatively to find out the exact IOL power.

VII. Keratometry

The evaluation of the corneal curvature preoperatively and postoperatively is essential for postoperative astigmatic evaluation. Gross examination of corneal curvature can be made with keratoscope, but more accurate determination can be made only with keratometer.

Keratometry was done for all the patients preoperatively and postoperatively at 6 months followup.

VIII. Surgical Procedure

Group – A – Phacoemulsification was performed under local anesthesia. A fornix based conjunctival flap was made. A light cattery was applied. Half thickness scleral frown incision of about 5 to 5.5mm and about 2.5mm from surgical limbus was made using a blade and a tunnel was constructed by using crescent knife.

Dissection extending upto 0.5mm to 1mm into the clear cornea. Paracentesis was made using 3.5mm keratome making an internal corneal valve of 0.5 to 1mm. Viscoelastic were used liberally. A continuous curvilinear capsulorhexis was performed using a bent 26g needle. Hydrodissection and hydrodelineation was done. Phacoemulsification was done using 30^0 tip by either divide and conquer or chip and flip method. The epinucleus and cortex was removed by irrigation and aspiration probe. The scleral tunnel was enlarged and single piece 5mm optic PMMA lens was implanted. Tunnel was checked for leak and conjunctiva was apposed by cautery.

Group – B – Manual SICS was performed under local aneshetia. The initial steps surgery are the same like phacoemulsificatin except the incision size is 6mm – 6.5mm. Large capsulorhexis was performed. Hydrodissection and hydrodelination was performed with a bent canula, aiming for prolapsing the nucleus into the Anterior chamber. Tunnel was extended with internal entry wider than the external. Under the cover of viscoelastics the nucleus was hydroextracted out of the anterior chamber with the aid of irrigating vectis. The epinucleus and cortex were removed with the simcoe canula. Single piece PMMA PC IOL was inserted in the bag. Wound integrity was checked and conjunctiva was apposed.

Any complication arising during the operation or patients stay at the hospital was recorded.

Induced Astigmatism was calculated as absolute change in cylinder (without regard to axis) at six months postoperative period by vector analysis using rectangular coordinates (Jaffe's method).

RESULTS

DEMOGRAPHICS

I. Sex Distribution in Phacoemulsification

MALE	FEMALE
58%	42%

II. Sex Distribution in Manual SICS

MALE	FEMALE
64%	36%

III. Age Distribution in Phacoemulsification

40-50 Years	9	18%
51-60 Years	20	40%
61-70 Years	14	28%
Above 70 Years	7	14%

Summarizes the Patient Age distribution in group A (Phacoemulsification)

In this study majority of patients were in the age group of 51-60 yrs (40%), 28% of the patients were in the age group 61-70 years, followed by 18% and 14% in the age group of 40-50 years and above 70 years respectively.

IV. Age Distribution in Manual SICS

40-50 Years	14	28%
51-60 Years	20	40%
61-70 Years	13	26%
Above 70 Years	3	6%

Table summarizes the patient age distribution in group B Manual SICS

In this study, majority of patients was in the age group of 51-60 years (40%) and 61-70 years (26%) and 28% of the patients were in the age group 40-50 years, followed by 6% in the age group of above 70 years.

V. Type of Cataract in Phacoemulsification

Neclear Sclerosis	18	36%
Immature cortical	17	34%
PSCC	15	30%

Table 3 shows the types of cataract in group A. Nuclear sclerosis was seen in 18 patients (36%), Immature Cortical in 17 (34%) and Posterior Sub Capsular in 15 Patients (30%).

VI. Type Of Cataract In Manual SICS

PSCC	9	18%
Immature Cortical	7	14%
Nuclear Sclerosis	14	28%
Mature Cataract	20	40%

Table 4 shows the types of cataract in group B. Nuclear sclerosis was seen in 14 patients (28%) Immature Cortical in 7 patients (14%) and Posterior Sub Capsular in 9 Patients (18%), Mature cataract in 20 patients (40%).

Table 7

Preoperative corrected / A	**No. of cases**	**Percentage**
PL+	-	-
HM	3	6%
1/60	4	8%
2/60	1	2%
3/60	2	4%
4/60	5	10%
5/60	-	-
6/60	5	10%
6/36	10	20%
6/24	7	14%
6/18	11	22%
6/12	2	4%
6/9	-	-
Total	**50**	

Shows preoperative best corrected visual acuity in Group A

Table 8

Preoperative corrected / A	No. of cases	Percentage
PL+	0	0
HM	19	38%
1/60	1	2%
2/60	5	10%
3/60	0	-
4/60	2	14%
5/60	2	4%
6/60	2	4%
6/36	3	6%
6/24	4	8%
6/18	10	20%
6/12	2	4%
Total	**50**	

Shows preoperative best corrected visual acuity in Group B

Table 9

Group	N	Mean	SD	Standard Error Mean
Induced astigmatism A	50	0.4566	0.5178	7.321E.02
Induced astigmatism B	50	0.7456	0.7826	0.1107

Table 9 shows the induced astigmatism. The mean astigmatism in Group A is 0.4566 and in Group B is 0.7456

Table 10

Independent Sample Test

		Levene's test for equality of variances		t-test for equality of means						
		F	Sig	1	d	Sig (2-tailed)	Mean difference	St. Error Difference	95% confidence interval of the differences	
									Lower	Upper
Induced astigmatism	Equal variances assumed	7.770	.006	2.103	98	.038	.2790	.1727	1.564F-02	.542
	Equal Variances not assumed			2.103	85.005	.038	.2790	.1327	1.514E-02	.542

Table10 - shows p value is 0.038. since it if <0.05 the induced astigmatism is significant.

Table 11

Change in Astigmatism	Group A	Group B	Total
Nil	25(50%)	17(34%)	42(42%)
0-1	20(40%)	22(44%)	42(42%)
1-2	5(10%)	6(12%)	11(11%)
2+	0(0%)	5(10%)	5(5%)
Total	50(100%)	50(100%)	100(100%)

Table 11 shows the change in astigmatism. Preoperative to Postoperative state

Group A – 50% had nil astigmatism

40% had 0-1D astigmatism

10% had 1-2D astigmatism

Group B – 34% to had nil astigmatism

44% had 0-1D astigmatism

12% had 1-2D astigmatism

10% had +2D astigmatism

SUMMARY

This was a retrospective study conducted at Madurai Medical College from 2008 2009

GROUP A

Sex Distribution was

Among 50 patients

58% were male and 42% were Female

Age Distribution was

40-50 years 18%

51-60 years 40%

61-70 years 28%

Above 70 Years 14%

Type of Cataract was

Nuclear Sclerosis	-	36%
Immature Cortical Cataract	-	34%
PSCC	-	30%

The calculated Induced Astigmatism was

Group A – 50% had nil astigmatism

40% had 0-1D astigmatism and

10% 1-2 D astigmatism

GROUP B

Sex Distribution

Male – 64%

Female - 36%

Age Distribution

40-50 years 28%

51-60 years 40%

61-70 years 26%

Above 70 Years 6%

Type of Cataract was

Nuclear Selerosis	-	28%
Immature Cortieal Cataract	-	14%
PSCC	-	18%
Mature Cataract	-	40%

The calculated Induced Astigmatism was

34% had nil astigmatism

44% had 0-1D astigmatism and

12% 1-2 D astigmatism

10% had more than 2 D astigmatism

The mean Induced Astigmatism was

Group A	–	0.4566
Group B	–	0.7456

The Post Operative best corrected visual Acuity at 6 Months was

Group A	–	90% had 6/6
		5% had 6/9
		5% had 6/12 due to PCO
Group B	–	85% had 6/6
		10% had 6/9
		5% had 6/12 due to PCO

DISCUSSION AND CONCLUSION

Cataract surgery has refined tremendously in recent years mainly to fulfill the expectation of the patients, that is early visual rehabilitation and minimal induced astigmatism. SICS has come as a great boon in meeting this demand. It reduces the amount of postoperative astigmatism and decreases the time for wound stabilization. Increased reductions in the amount of surgically induced cylinder are now obtainable with newer techniques in cataract surgery. By using a small incision and allowing the wound to be self-sealing. Surgically induced astigmatism can be minimized by using a small incision and allowing the wound to be self-sealing can see faster stabilization of the wound with a small degree of astigmatic decay. Manual SICS is slowly emerging as an alternative technique on Phacomulsification in developing countries. Manual SICS is not a machine dependent technique and incurs less cost. In developing countries Phacoemulsification costs nearly 5-10 times more than standard ECCE with IOL, whereas Manual SICS costs nearly same or even slightly less than ECCE with IOL.

This was a retrospective study conducted at Madurai Medical college, Madura. To compare the surgical induced astigmatism in patients who underwent Phacoemulsification with a tunnel size of 5 mm and Manual SICS with a tunnel size of 6-6.5 mm wherein a rigid PMMA IOL was implanted (5mm optic in Phaco group and 6mm optic in Manual SICS group).

The surgical induced astigmatism was calculated as an absolute change in cylinder (without regard to axis) at 6 months after surgery.

The astigmatism of the patients was calculated using a Baunch & Lomb Keratometer, Keratometry was done on all patients both preoperatively and at 6 month follow-up. Surgically induced astigmatism was calculated by Vector analysis using rectangular coordinates (Jaffe's Method).

The p value (t-test) was calculated using SPSS software. This study showed that the surgery induced astigmatism in 0.4566 $\pm$ S.D. 0.52 in Group A and 0.7456 $\pm$ S.D. 0.78 in group B. The p value 0.38% ($p \leq 0.05$) which shows that there can be significant difference in the mean induced astigmatism between the two groups.

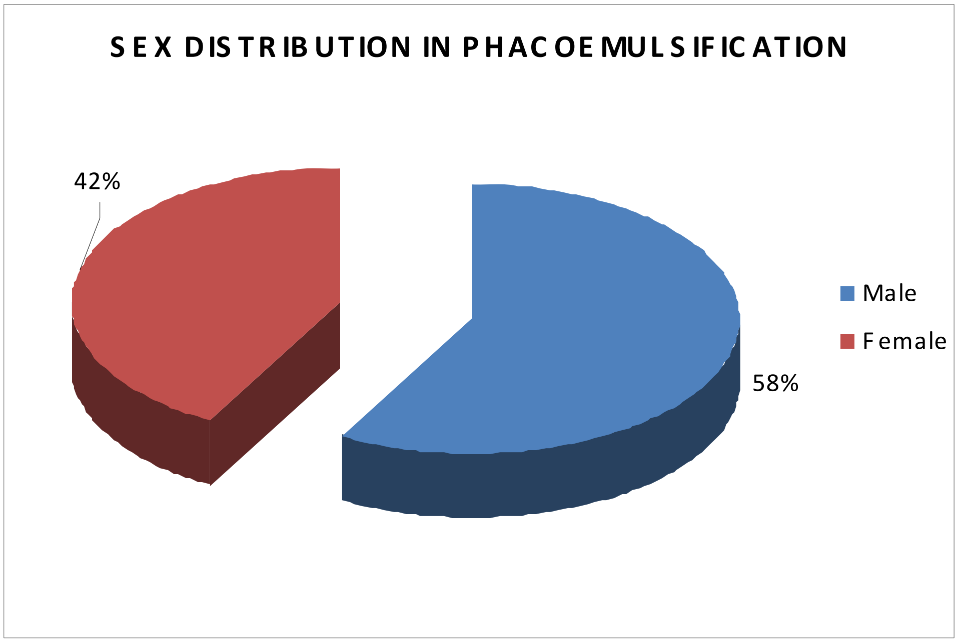
Even though the difference in surgically induced astigmatism in group A and b is statistically significant but the actual difference is only about 0.29D.

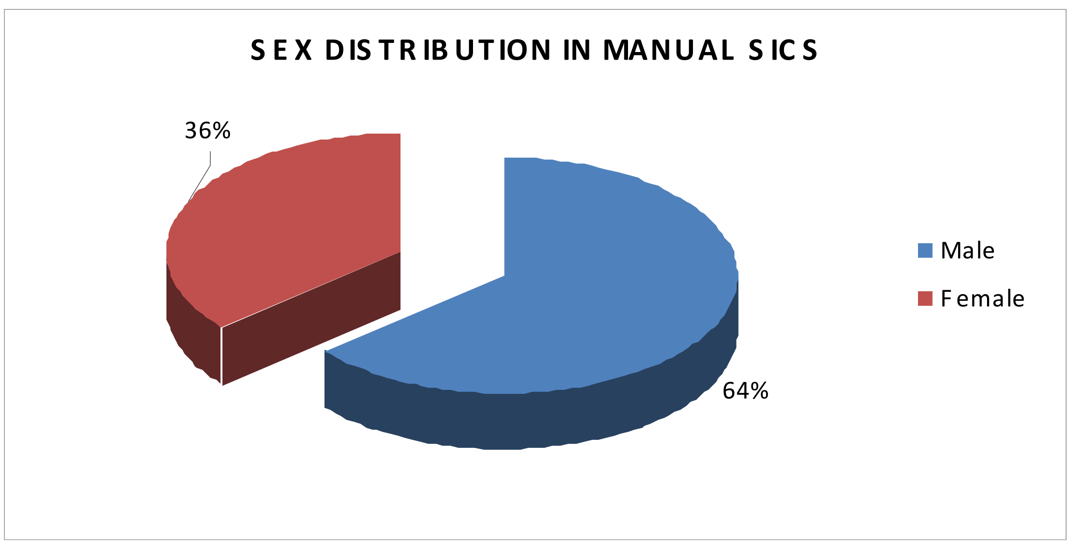
A study of no stitch surgery was done by Hiyb et al wherein surgical induced astigmatism between 5.2mm & 7mm incision was compared after 3 months. Here it was seen that 5.2 mm incision produced average surgical induced astigmatism of about 0.75D and 0.52D in 7mm group. But in our study 5mm incision group produced 0.45D and 6-6.5mm incision produced 0. 74D astigmatism.

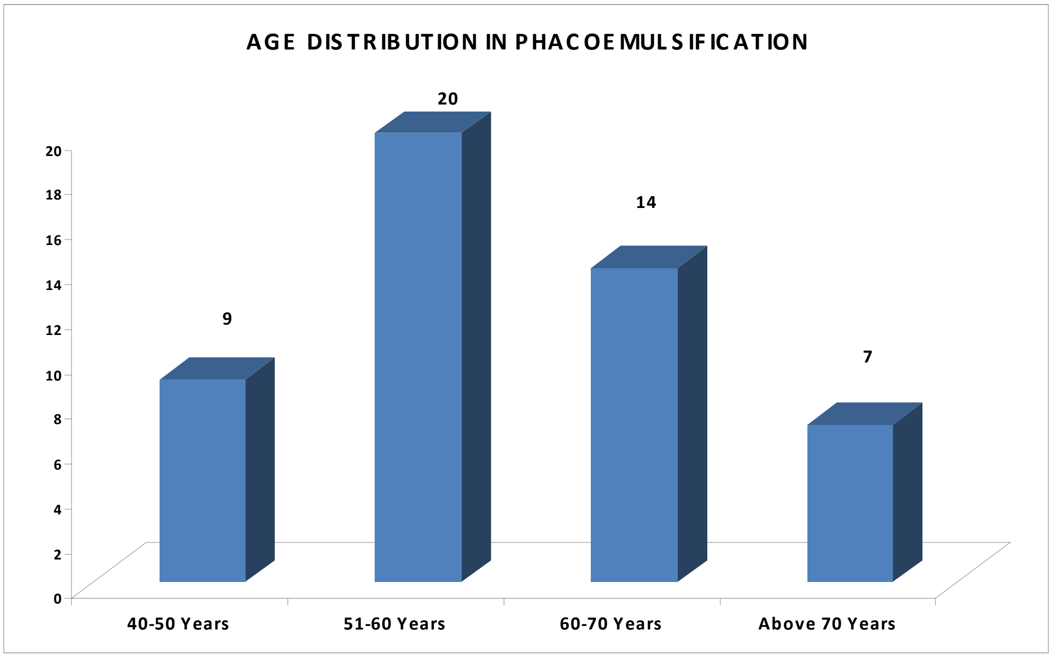
Many factors contribute to the surgical induced astigmatism like length of incision, distant of incision form the limbus, shape of incision, use of cautery and technique of wound construction. One has to respect the astigmatism neutral zone as much as possible. Less induced astigmatism (against the rule) can be obtained by making a posterior incision i.e. about 2 – 2.5mm from limbus. Keeping in mind the astigmatic neutral zone.

Phacoemlsification is difficult in cases like pseudoexfoliation, grade IV nuclear cataract, subluxated lenses and hypermature cataracts. In such situation even most experienced surgeons hesitate in doing Phacoemulsification. However in such situation Manual SICS is certainly a desirable goal. Manual SICS can be performed comfortably in these cases rather than converting them to standard extracapsular surgery.

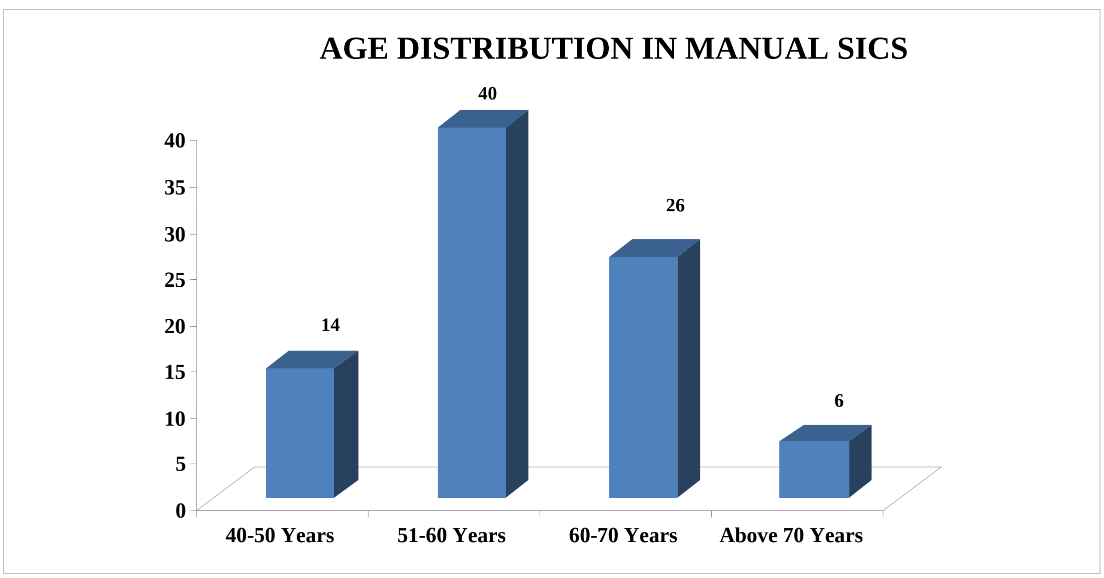
If the surgeon has mastered Manual SICS technique, it comes as a great help when the surgeon has intra operative difficulty or machine failure during phacoemulsification, wherein he can easily convert to this technique and give comparable if not equivalent result.


SEX DISTRIBUTION IN PHACOEMULSIFICATION
42%
58%
Male
Female

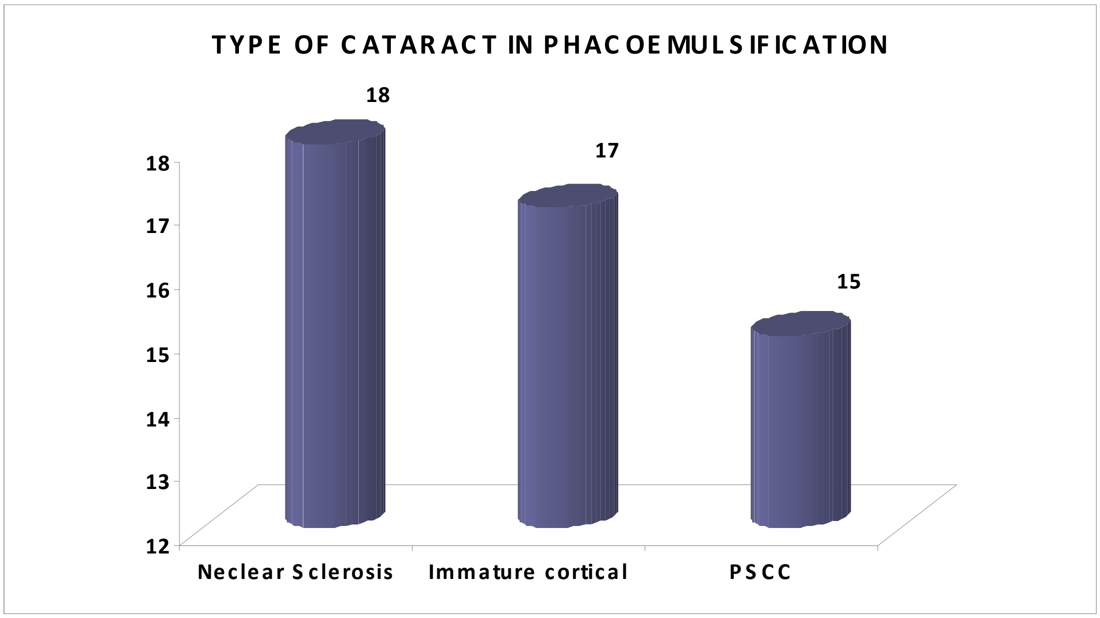

SEX DISTRIBUTION IN MANUAL SICS
36%
64%
Male
Female

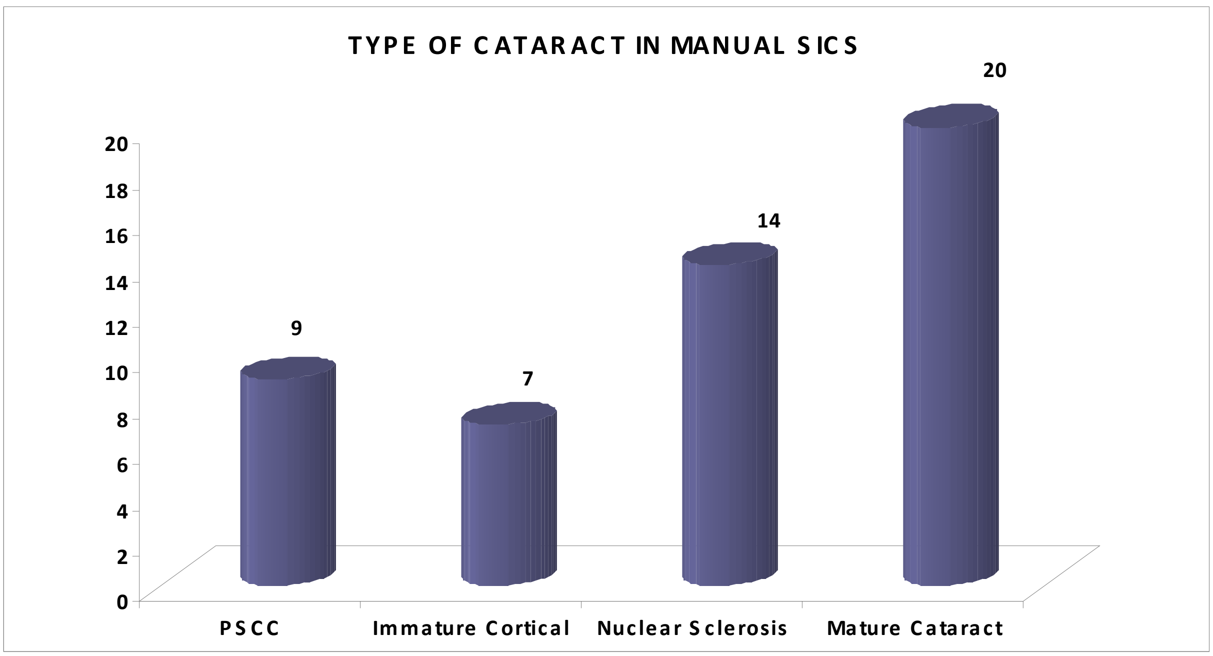


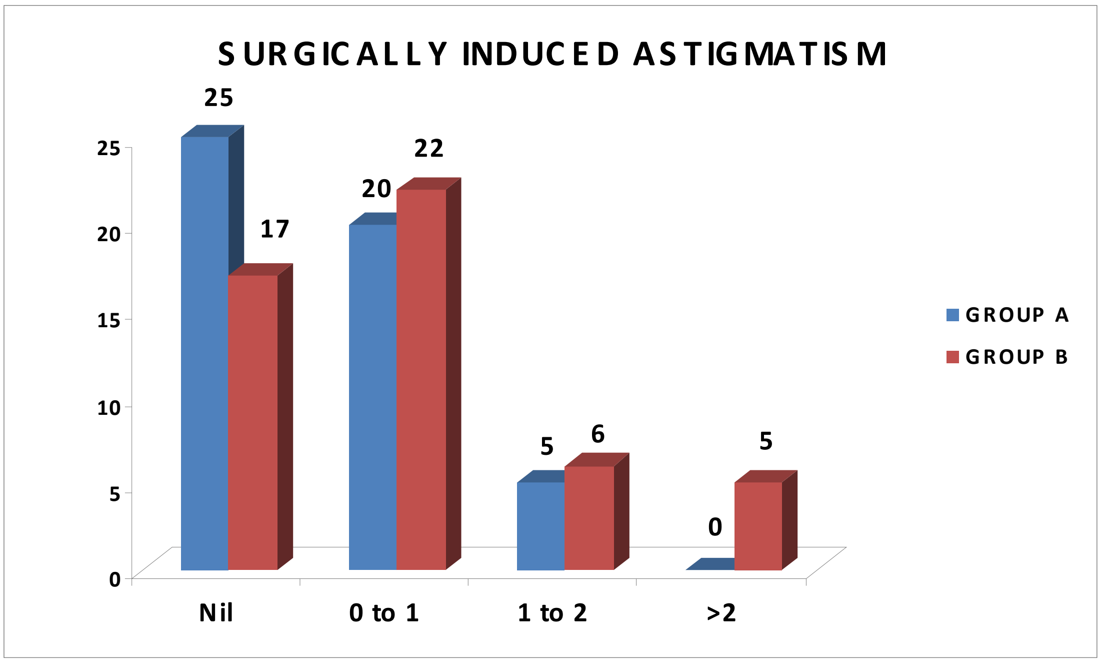
AGE DISTRIBUTION IN PHACOEMULSIFICATION
20
18
16
14
12
10
8
6
4
2
0
9
20
14
7
40-50 Years
51-60 Years
60-70 Years
Above 70 Years



AGE DISTRIBUTION IN MANUAL SICS
40
35
30
25
20
15
10
5
0
14
40
26
6
40-50 Years
51-60 Years
60-70 Years
Above 70 Years


TYPE OF CATARACT IN PHACOEMULSIFICATION
18
17
15
18
17
16
15
14
13
12
Neclear Sclerosis
Immature cortical
PSCC


TYPE OF CATARACT IN MANUAL SICS
20
18
16
14
12
10
8
6
4
2
0
9
7
14
20
PSCC
Immature Cortical
Nuclear Sclerosis
Mature Cataract



SURGICALLY INDUCED ASTIGMATISM
25
17
20
22
5
6
0
5
0
5
10
15
20
25
Nil
0 to 1
1 to 2
>2
GROUP A
GROUP B

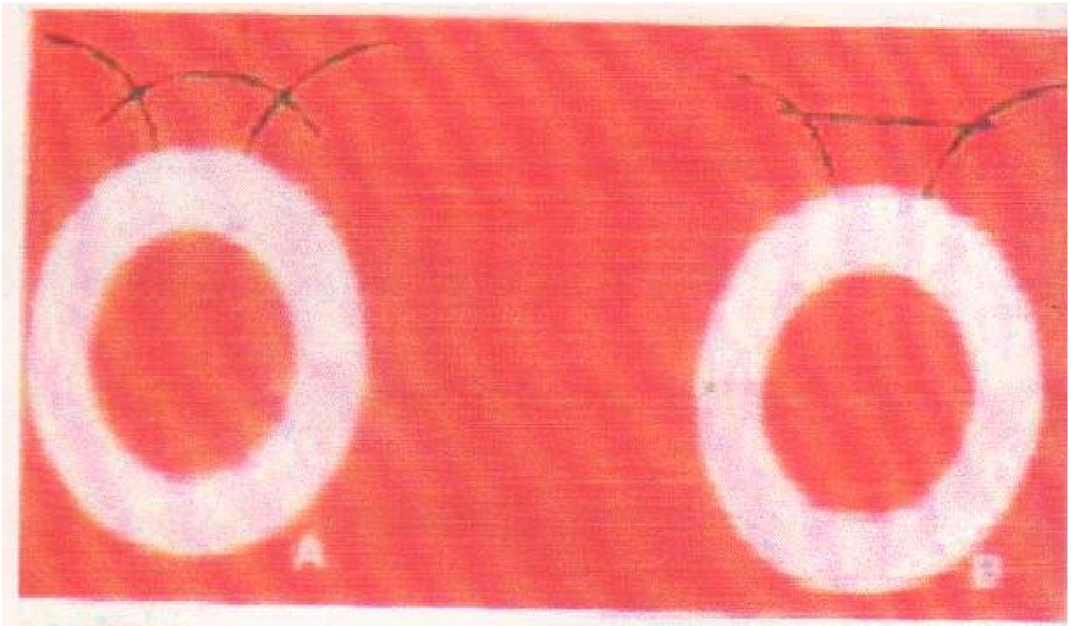
MASTER CHART												
S.NO	NAMES	AGE	SEX	I.P.No.	TYPE OF CATARACT	PRE OP UCVA	PRE OP BCVA	PRE OP K1	PRE OP K2	TYPE OF Sx	POST OP UCVA	POST OP BCVA
1	GURUSAMY	49	M	42688	nuclear sclerosis	6/36	6/18	42.00	42.50	Phaco	6/9	6/6
2	AMMAVASI	53	M	42610	PSCC	6/36	6/18	46.75	45.00	Phaco	6/6	6/6
3	JEYTHUNISHA	59	F	40412	immature cortical	6/60	4/60	39.75	40.00	Phaco	6/36	6/6
4	SATHASIVAMPILLAI	42	M	42608	PSCC	6/60	6/36	44.50	44.50	SICS	6/9	6/6
5	PALASAMY	56	M	42609	nuclear sclerosis	1/60	4/60	43.75	42.50	SICS	6/36	6/6
6	DHANUSH	58	M	41385	nuclear sclerosis	1/60	6/60	38.50	38.50	SICS	6/36	6/9
7	ANAND	54	M	62401	immature cortical	6/36	6/24	41.50	41.50	Phaco	6/12	6/6
8	THIRUMALAI	62	M	62417	nuclear sclerosis	1/60	2/60	40.75	42.25	SICS	6/36	6/6
9	ALAGIRI	60	M	354474	Mature cataract	HM	HM	42.50	40.75	SICS	6/36	6/6
10	ALAGAMMAL	62	F	65152	immature cortical	6/60	6/24	47.50	47.75	Phaco	6/12	6/6
11	PANDI	64	M	65159	Mature cataract	HM	HM	44.	43.00	SICS	6/24	6/6
12	PERIYASAMY	71	M	65328	nuclear sclerosis	HM	HM	42.50	41.75	Phaco	6/24	6/12
13	MARIYAPPAN	66	M	65470	Mature cataract	HM	HM	41.	40.00	SICS	6/12	6/6
14	DHAYALAN	45	M	65308	PSCC	6/36	6/18	41.75	44.75	Phaco	6/9	6/6
15	RAMU	56	M	65231	nuclear sclerosis	2/60	5/60	44.25	43.75	SICS	6/36	6/6
16	MOOKAMMAL	66	F	65311	immature cortical	3/60	6/60	42.75	43.00	Phaco	6/36	6/6
17	VENKATASAMY	49	M	61418	immature cortical	5/60	6/24	43.75	41.00	SICS	6/24	6/6
18	RAMALAKSHMI	60	F	65312	immature cortical	6/60	6/36	41.00	40.75	Phaco	6/12	6/6
19	ARUMUGAM	71	M	65579	Mature cataract	HM	HM	40.75	43.25	SICS	6/60	6/12
20	VEERANNAN	48	M	65232	PSCC	5/60	6/24	43.75	45.00	SICS	6/6	6/6
21	MARUTHARAJA	59	M	65676	Mature cataract	HM	HM	45.00	43.50	SICS	6/60	6/9
22	MOOKAIYAN	56	M	65718	immature cortical	6/60	6/36	40.75	42.00	Phaco	6/12	6/6
23	ABDULSALAM	45	M	65716	PSCC	6/36	6/18	47.50	43.50	SICS	6/6	6/6
24	MUNIYAMMAL	67	F	65711	PSCC	6/60	6/24	45.25	45.75	Phaco	6/12	6/6
25	GANESHAN	58	M	65627	nuclear sclerosis	6/60	6/36	45.25	44.75	SICS	6/9	6/6

S.NO	NAMES	AGE	SEX	I.P.No.	TYPE OF CATARACT	PRE OP UCVA	PRE OP BCVA	PRE OP K1	PRE OP K2	TYPE OF Sx	POST OP UCVA	POST OP BCVA
26	ALAGAR	72	M	65614	nuclear sclerosis	1/60	1/60	44.00	44.50	Phaco	6/36	6/12
27	LAXMI	50	F	65729	nuclear sclerosis	1/60	2/60	42.25	42.75	Phaco	6/24	6/9
28	THIRUMANI	54	F	65725	immature cortical	6/36	6/18	40.50	41.25	Phaco	6/6	6/6
29	RAMAKRISHNAN	49	M	65412	immature cortical	6/60	6/24	44.00	43.75	SICS	6/12	6/6
30	SAKTHIVEL	66	M	65753	nuclear sclerosis	1/60	4/60	40.00	40.00	Phaco	6/18	6/6
31	RASU	49	M	65746	immature cortical	6/60	6/18	43.50	42.50	SICS	6/16	6/6
32	LAXMI	69	F	65485	immature cortical	1/60	3/60	46.00	47.00	Phaco	6/12	6/6
33	AYYAKANNU	47	M	65818	PSCC	6/36	6/18	46.00	45.25	Phaco	6/12	6/6
34	SINGARAVELU	60	M	65192	immature cortical	6/36	6/18	45.75	45.50	Phaco	6/9	6/6
35	RAKKAMMAL	57	F	65820	Mature cataract	HM	HM	41.25	40.50	SICS	6/36	6/6
36	PUSHPAM	61	F	95797	immature cortical	6/60	6/24	41.25	42.50	Phaco	6/6	6/6
37	AYYAMMAL	59	F	65572	Mature cataract	HM	HM	43.75	44.25	SICS	6/36	6/6
38	DURAIYAPANDI	52	M	65802	PSCC	6/24	6/18	41.75	40.50	Phaco	6/12	6/6
39	PONNUTHAI	68	F	65756	Mature cataract	HM	HM	44.50	45.75	SICS	6/36	6/6
40	PERIYAPULIYAN	71	M	65784	nuclear sclerosis	1/60	1/60	44.50	45.75	Phaco	6/18	6/6
41	KARUTHAMMAL	69	F	65852	nuclear sclerosis	1/60	1/60	42.25	44.50	Phaco	6/24	6/9
42	PAPPATHI	63	F	65814	Mature cataract	HM	HM	41.75	42.50	SICS	6/24	6/6
43	ARUMUGAM	45	M	65885	PSCC	6/24	6/18	40.50	41.75	SICS	6/6	6/6
44	NATCHIYAMMAL	62	F	66044	immature cortical	6/60	6/60	45.75	46.50	Phaco	6/24	6/6
45	KALATHAN	46	M	66032	PSCC	6/36	6/18	47.00	47.20	Phaco	6/9	6/6
46	SATHANATHAN	61	M	66025	Mature cataract	HM	HM	43.25	42.00	SICS	6/60	6/9
47	OYYAMMAL	51	F	65936	immature cortical	6/60	6/36	44.25	42.75	Phaco	6/12	6/6
48	SUBRAMANIYADEVA	57	M	66026	nuclear sclerosis	2/60	2/60	42.25	44.50	SICS	6/24	6/6
49	SHANMUGAM	72	M	66121	nuclear sclerosis	HM	HM	41.75	42.50	Phaco	6/24	6/12
50	MUTHU	64	M	66168	nuclear sclerosis	2/60	2/60	46.25	45.50	SICS	6/12	6/6
51	RAJENDRAN	47	M	66125	PSCC	6/60	6/18	40.25	40.75	SICS	6/9	6/6
52	MEENAKSHI	67	F	65997	Mature cataract	HM	HM	44.75	45.00	SICS	6/36	6/12

S.NO	NAMES	AGE	SEX	I.P.No.	TYPE OF CATARACT	PRE OP UCVA	PRE OP BCVA	PRE OP K1	PRE OP K2	TYPE OF Sx	POST OP UCVA	POST OP BCVA
53	PANDI	53	M	64440	nuclear sclerosis	6/63	6/36	45.00	45.00	Phaco	6/6	6/6
54	ANNATHAI	56	F	66173	nuclear sclerosis	1/60	6/60	40.75	42.50	SICS	6/12	6/6
55	ALAGUMALAI	66	M	66741	immature cortical	4/60	4/60	43.75	42.50	Phaco	6/18	6/6
56	GANAPATHY	59	M	66853	Mature cataract	HM	HM	43.50	44.50	SICS	6/36	6/6
57	VADIVU	55	F	66852	PSCC	6/60	6/36	43.25	43.25	Phaco	6/12	6/6
58	MUTHURAKKU	59	F	66899	nuclear sclerosis	1/60	1/60	47.00	45.00	SICS	6/24	6/6
59	SAVARIYAPPAN	63	M	66841	nuclear sclerosis	3/60	4/60	44.75	45.25	Phaco	6/24	6/6
60	CHINNAN	72	M	66897	Mature cataract	HM	HM	45.50	46.50	SICS	6/60	6/9
61	ARUMUGATHAMMAI	50	F	66912	PSCC	6/60	6/36	41.5	41.50	Phaco	6/6	6/6
62	MOIHDEENBASHA	57	M	66817	PSCC	5/60	6/24	46.75	45.50	Phaco	6/36	6/9
63	MUTHU	45	M	661915	PSCC	6/60		46.00	46.00	SICS	6/6	6/6
64	SUBBU	64	M	66924	nuclear sclerosis	6/60	6/60	43.50	44.50	Phaco	6/36	6/12
65	SULTHAN	45	M	66644	PSCC	6/36	6/12	45.25	44.25	Phaco	6/6	6/6
66	ARUMUGAM	60	M	66849	PSCC	6/60	6/60	45.00	45.00	Phaco	6/36	6/9
67	MAYANDI	54	M	66718	immature cortical	6/36	6/18	39.50	40.50	SICS	6/6	6/6
68	PANDURANGAM	66	M	66999	nuclear sclerosis	6/60	6/36	46.75	45.50	Phaco	6/12	6/6
69	NARAYANAN	53	M	381219	nuclear sclerosis	1/60	2/60	40.75	42.50	SICS	6/24	6/6
70	MOOKADURAI	58	M	67005	immature cortical	6/60	6/36	43.75	45.75	Phaco	6/9	6/6
71	ADHIMOOLAM	66	M	66922	Mature cataract	HM	HM	41.50	43.75	SICS	6/36	6/6
72	GANDHI SUNDAR	63	M	68363	nuclear sclerosis	4/60	4/60	46.00	45.75	Phaco	6/24	6/6
73	MAYANDI	43	M	60420	PSCC	6/24	6/12	44.00	44.00	SICS	6/6	6/6
74	RAMASAMY	62	M	66913	Mature cataract	HM	HM	43.00	45.75	SICS	6/24	6/6
75	RASUDEVAR	52	M	66895	immature cortical	6/36	6/24	42.00	42.50	Phaco	6/36	6/6
76	VANNIMUTHU	64	M	66863	Mature cataract	HM	HM	45.75	44.75	SICS	6/36	6/6
77	SAVARIYAPPAN	77	M	66841	nuclear sclerosis	6/60	1/60	46.50	44.00	Phaco	6/36	6/6
78	ANGUSAMY	52	M	66596	immature cortical	6/24	6/18	42.00	45.75	SICS	6/9	6/6
79	MUTHAIYAPILLAI	48	M	66592	PSCC	6/36	6/12	43.40	43.40	Phaco	6/6	6/6

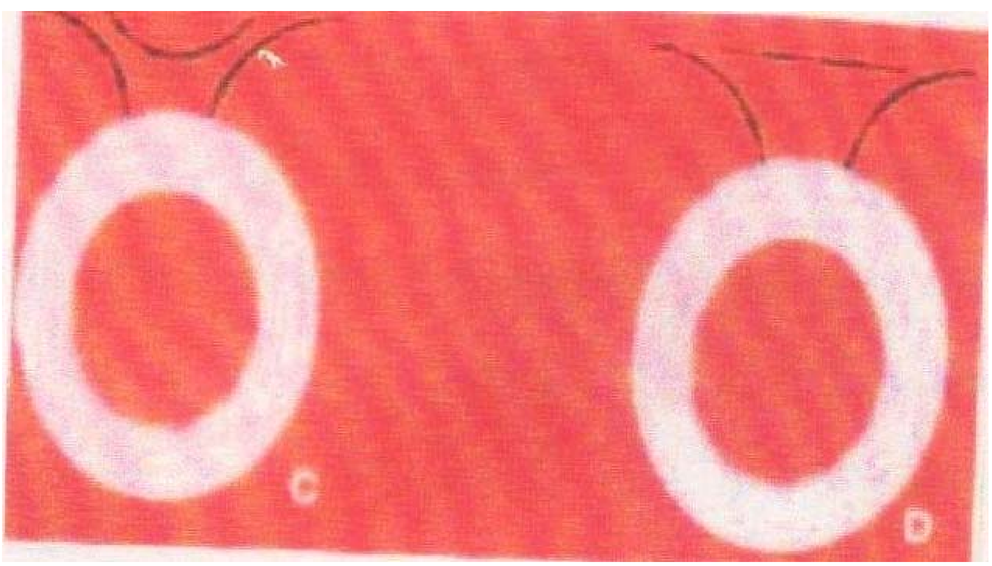
S.NO	NAMES	AGE	SEX	I.P.No.	TYPE OF CATARACT	PRE OP UCVA	PRE OP BCVA	PRE OP K1	PRE OP K2	TYPE OF Sx	POST OP UCVA	POST OP BCVA
80	MAYAN	47	M	66634	Mature cataract	HM	HM	44.50	45.75	SICS	6/24	6/6
81	SUNDRAMOORTHY	57	M	65852	nuclear sclerosis	4/60	4/60	42.25	41.50	SICS	6/36	6/6
82	RAJA	51	M	65777	PSCC	6/36	6/18	45.50	45.75	Phaco	6/12	6/6
83	PALPANDI	65	M	61818	Mature cataract	HM	HM	41.50	43.00	SICS	6/24	6/6
84	SURESH	67	M	65801	nuclear sclerosis	1/60	6/60	40.50	41.50	Phaco	6/36	6/6
85	GUGAN	68	M	65464	Mature cataract	HM	HM	40.50	42.75	SICS	6/36	6/6
86	VENKATESH	52	M	65137	immature cortical	6/36	6/18	44.75	44.75	Phaco	6/6	6/6
87	KALIMUTHU	72	M	65614	nuclear sclerosis	HM	HM	44.25	43.75	Phaco	6/60	6/9
88	THANGARAJ	51	M	65730	nuclear sclerosis	2/60	2/60	41.75	42.50	SICS	6/36	6/6
89	SEKAR	47	M	65625	nuclear sclerosis	6/24	6/24	47.25	47.50	Phaco	6/12	6/6
90	CHANDRAN	51	M	65509	nuclear sclerosis	1/60	5/60	45.00	45.00	SICS	6/24	6/6
91	MUTHUSAMY	53	M	65497	nuclear sclerosis	6/60	6/36	43.25	45.00	Phaco	6/12	6/6
92	MULLAIVENDHAN	44	M	65576	PSCC	6/24	6/18	40.25	41.75	SICS	6/6	6/6
93	KRISHNAN	52	M	65554	nuclear sclerosis	5/60	6/36	40.75	43.00	SICS	6/12	6/6
94	NELLAIYAPPAN	46	M	65469	PSCC	6/36	6/12	46.50	43.50	SICS	6/6	6/6
95	NAGARAJAN	50	M	64449	PSCC	6/60	6/36	41.75	.43.00	Phaco	6/12	6/6
96	MANIVEL	49	M	65321	immature cortical	3/36	6/24	44.50	44.50	SICS	6/9	6/6
97	RAKKAIYEE	55	F	65313	PSCC	6/60	6/18	40.00	40.75	Phaco	6/6	6/6
98	PERUMAL	47	M	65301	immature cortical	6/36	6/18	41.75	40.50	SICS	6/6	6/6
99	PAUL	71	M	65430	nuclear sclerosis	3/60	3/60	42.75	43.75	Phaco	6/60	6/12
100	PETCHI	56	F	65469	immature cortical	6/60	6/18	42.75	42.75	SICS	6/12	6/6

THE INCISIONAL FUNNEL



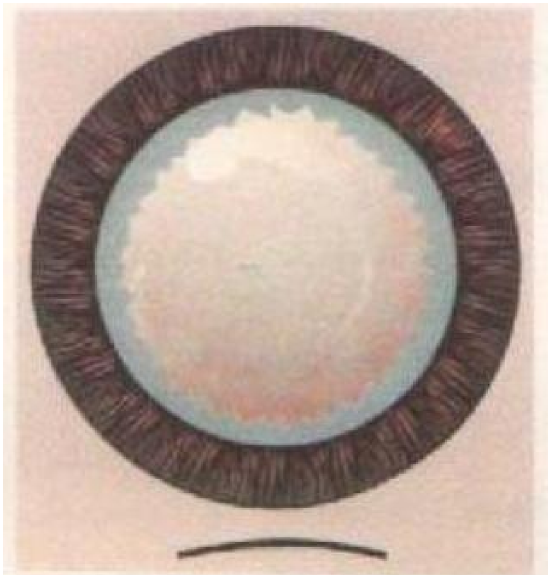
A- CURVILINEAR INCISION MADE PARALLEL TO THE LIMBUS CROSSES OUT OF THE INCISIONAL FUNNEL – UNSTABLE

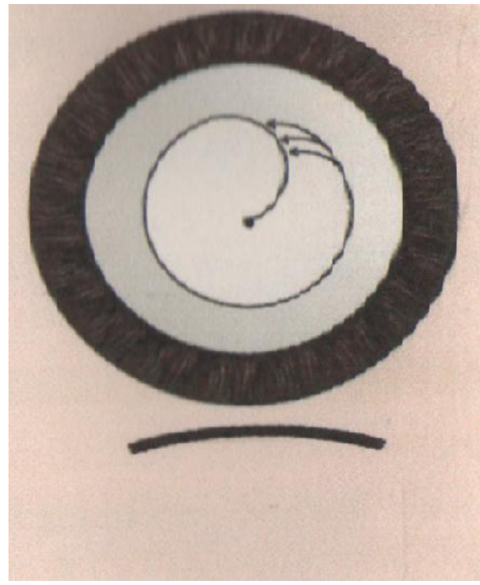
B- THE STRAIGHT INCISION – FALLS OUT SIDE THE FUNNEL STABLE THAN A



C- FROWN/ CHEVRON INCISION – LIE ENTIRELY WITH IN THE FUNNEL – MORE STABLE

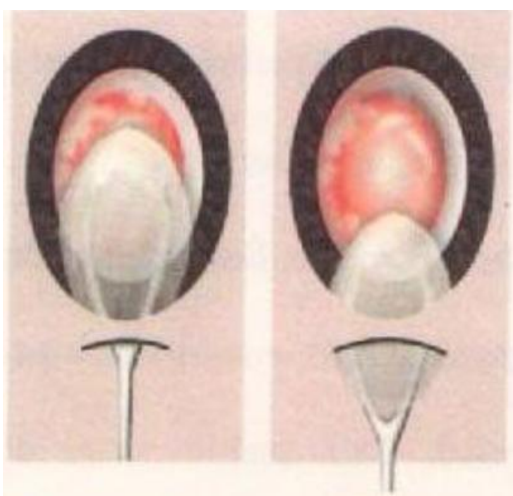
D- LINEAR INCISION A WAY FROM THE LIMBUS – MORE STABLE BUT HAMPERS THE VIEW

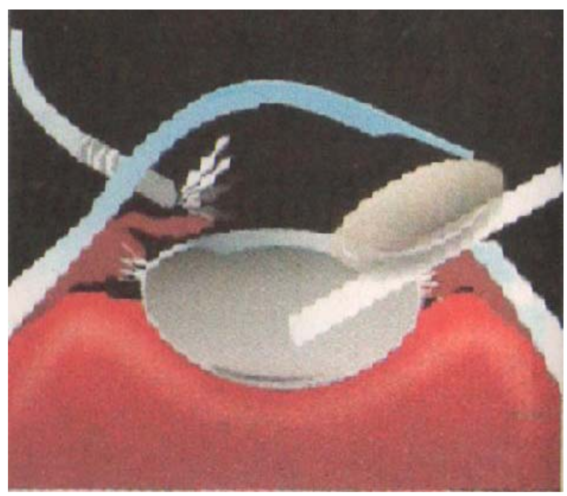




CANOPENER CAPSULOTOMY

COMPLETION OF RHEXIS FROM OUTSIDE IN (CCC)

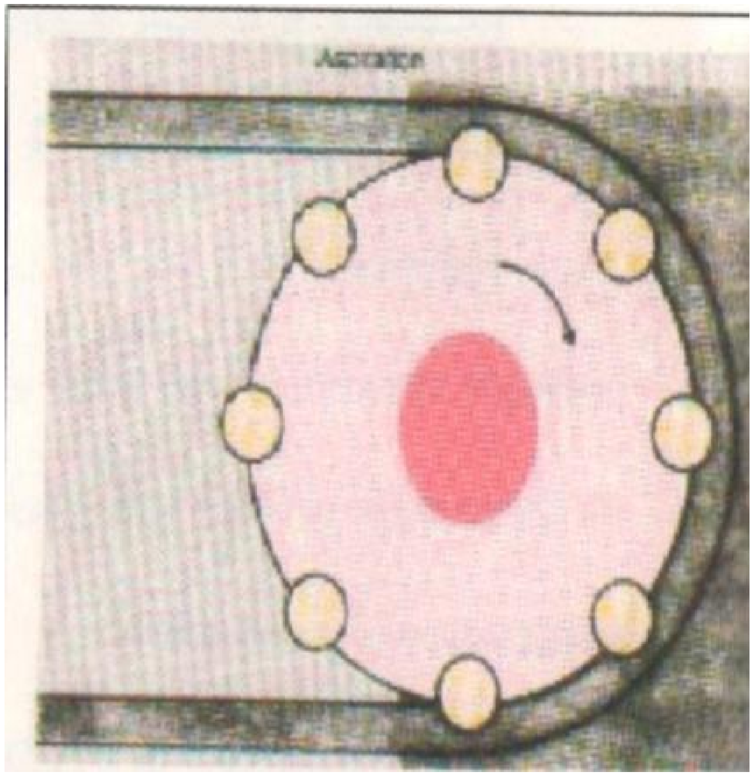




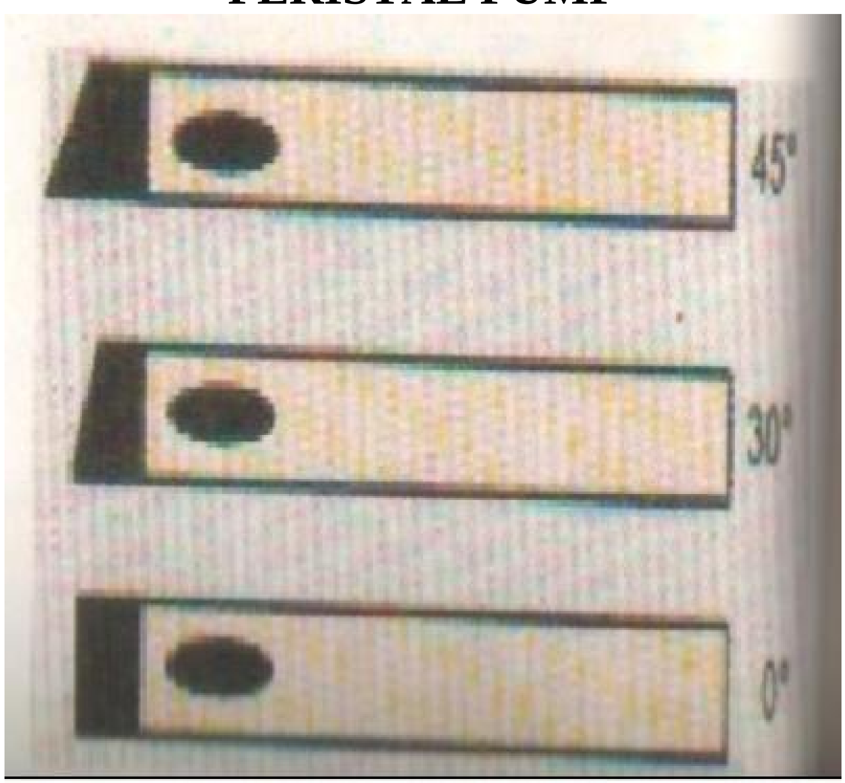
NUCLEUS EXTRACTION WITH AN IRRIGATING VECTIS

MODIFIED BLUEMENTHAL TECHNIQUE

PHACO MACHINE



PERISTAL PUMP



PHACO TIPS

PROFORMA

Name______________________ Age ☐☐ Sex ☐ Male -1 Female -2

Type of Cataract: ☐

1. Nuclear sclerosis
2. Immature cortical
3. Posterior sub capsular
4. Mature cataract

Preoperative U.C.V.A ☐

Preoperative B.C.V.A ☐

Preoperative K1 ☐☐

Preoperative K2 ☐☐

Axix ☐

At 6 Months Follow – up

Postoperative U.C.V.A ☐

Postoperative B.C.V.A ☐

Post operative K1 ☐☐

Post operative K2 ☐☐

Axis ☐

This study was conducted at Madurai Medical college, Madurai from 2008 -2009 was a retrospective study. A total of 100 cases of cataracts were included in this study. The cases were divided into two groups of 50 each, Group A underwent Phacoemulsification and Group B underwent Manual SICS. Following observations were noted.

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